



U.S. Department of Energy
**Energy Efficiency
and Renewable Energy**

Bringing you a prosperous future where energy
is clean, abundant, reliable, and affordable



Energy Technology Solutions:

Public-Private Partnerships Transforming Industry

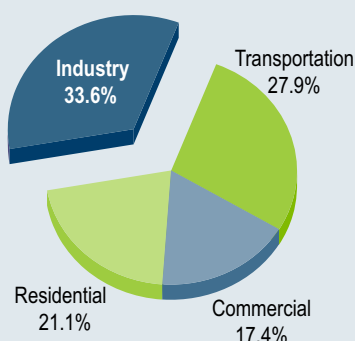
June 2006

Industrial Technologies Save Energy and Boost Competitiveness

U.S. industry consumes more energy than any other single sector of the economy.

U.S. Industry Consumes 32.6 Quadrillion Btu —

more than a third of all energy used in the United States



Challenges Facing U.S. Industry

- Increasing foreign competition
- Aging assets
- Rising energy costs
- High environmental compliance costs
- Shrinking R&D budgets for new technology
- Expectations for high return on investment
- Narrow profit margins

Most industrial facilities harbor significant opportunities for energy and cost savings.

The U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy (EERE) works with industry to reduce the energy intensity of manufacturing processes. Through the Industrial Technologies Program (ITP), DOE provides cost-shared funding so collaborative partnerships can research and develop more energy-efficient transformational technologies for industry. These advanced technologies are then commercialized by the private sector, including many small businesses.

In addition, ITP analyzes energy use to identify opportunities for significant energy savings, and works with industrial stakeholders to develop resources to realize energy savings industry-wide.

Benefits for the Industry and our Nation

- Save energy
- Reduce production costs
- Reduce use of toxic feedstocks
- Reduce emissions and by-products
- Promote economic growth
- Increase industrial competitiveness



Table of Contents

This document highlights ITP co-funded technologies available in the marketplace today. It also presents emerging technologies and other resources to help industry save energy.

Technologies for Today

Commercialized technologies available now for purchase

Industry Focus:

Aluminum	3
Chemicals	5
Forest Products	8
Glass	12
Metal Casting	14
Mining	16
Petroleum Refining	19
Steel	20

Cross-cutting Focus:

Auxiliary Equipment	23
Combustion	24
Forging and Heat Treating	26
Materials	27
Sensors and Process Control	29

Technical knowledge-based results improving processes today

Aluminum	31
Chemicals	32
Glass	33
Heat Treatment	34
Materials	34
Metal Casting	35
Steel	36

Technologies for Tomorrow

Promising technologies that are expected to reach the market within three years

Industry Focus:

Aluminum	37
Chemicals	38
Forest Products	42
Glass	45
Metal Casting	48
Mining	49
Steel	51

Cross-cutting Focus:

Combustion	53
Materials	54
Sensors and Process Control	56
Welding	60

Resources for Today

Tools, training, assessments, and other information to help companies recognize opportunities for low-cost and quick-payback process improvements

Resources	61
-----------	----



TECHNOLOGIES FOR TODAY

The following Commercially Available Technologies, developed with DOE support, are helping to improve U.S. competitiveness today in diverse industries.

Oxygen-Enhanced Combustion for Recycled Aluminum

New metal melting system reduces energy use and increases productivity



A new low-NO_x combustion burner is integrated with an onsite vacuum-swing-absorption (VSA) oxygen generation system to reduce oxygen consumption, NO_x emissions, and energy usage while increasing melting productivity. This new burner controls the mixing of fuel, air, and high-purity oxygen streams to improve flame quality. The VSA

system lowers emissions using a patented high-efficiency molecular sieve to remove nitrogen from the air. This technology can be used in metal melters for zinc, lead, copper, and ferrous materials.

Contact:

Russell Hewertson
Air Products & Chemicals, Inc.
(610) 481-5966
hewertjr@airproducts.com



Benefits:

- ▶ Reduces O₂ consumption and costs by 33%
- ▶ Increases production rate by 26%

Industry-wide energy savings
of 25 billion Btu since 1999

Detection and Removal of Molten Salts

A simple electrical probe detects and reduces chloride salts in molten aluminum



A new probe and filter technology detects and removes molten salts from aluminum alloys to ensure better quality casting. The electric probe measures chlorine content in real-time for a wide range of conditions, and the filter selectively removes the salts, preventing the formation of solid inclusions on ingot and casting

surfaces. The system's efficiency and capacity improve aluminum alloy quality and reduces rework.

Contact:

David Haack
Selee Corporation
(828) 693-0256 ext. 3369

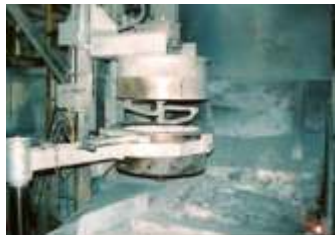


Benefits:

- ▶ Removes impurities and inclusions from molten aluminum
- ▶ Eliminates rejections and recasting due to salt contamination
- ▶ Improves aluminum ingot quality

Dross Boss™ Aluminum Reclaimer for Foundry Applications

Affordable metallic recovery system saves energy, reduces landfill waste streams

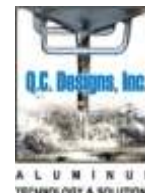


The Dross Boss™ reclaims metallics from hot dross and skim at their point of generation. The process reduces melting losses for foundries and other aluminum melters by recovering the contained metallics on-site. In some cases, the recovered metal may be

reintroduced to the generating process in molten form to produce additional energy savings. The reclaiming process may be run manually or with an automatic mixing cycle, and it can accommodate hot dross in quantities ranging from 10 to 500 pounds.

Contact:

Daniel Groteke
Q.C. Designs, Inc.
(269) 983-6859
dgroteke@cs.com



Benefits:

- ▶ Up to 80% metallic recovery from skim and dross
- ▶ Reduces energy used to transport and recover drosses at outside processors
- ▶ Avoids sending process salts to landfills

Small Business Association of Michigan's Innovation of the Year Award in 2000

Direct Chill Casting Model

Modeling and optimization of direct chill casting to reduce ingot cracking



A new direct chill (DC) casting model based on the proCAST software characterizes heat and stress conditions and solidification criteria, and assists in predicting crack formation during aluminum casting. Using this model, Secat helps aluminum producers optimize process parameters to optimize ingot geometry and reduce stress cracking and butt deformation, which account for a 5% production loss during DC casting. By

controlling the scrap level, this service reduces production costs and enables large energy savings.

Contact:

Todd Boggess
Secat, Inc.
(859) 514-4956 ext. 103
tboggess@secat.net



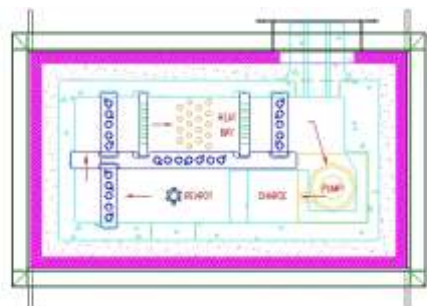
Benefits:

- ▶ Improves ingot consistency and quality
- ▶ Reduces production losses
- ▶ Eliminates butt sawing

Secat service used to optimize production for two aluminum plants

Isothermal Melting

Conductive heating improves energy efficiency and reduces metal oxidation



Isothermal melting is a process utilizing newly developed immersion heaters to supply melting energy through conduction with greater than 97% efficiency. These heaters are incorporated into a multi-bay continuous flow

system that further enhances the efficiency of melting, alloying, and purifying aluminum. The system's unique ability to control the flow system temperature allows molten metal to be recycled back into the molten pool at the same temperature from which it was withdrawn. The isothermal melting system eliminates the excess energy and higher temperatures encountered with traditional combustion systems that transfer energy by radiant heating.

Contact:

Dr. C Edward Eckert
Apogee Technology, Incorporated
(412) 798-9899
EDT58@aol.com



Benefits:

- ▶ Decreases costs by reducing metal lost to oxidation from 2-4% to less than 1%
- ▶ Can be retrofit to existing furnaces, increasing productivity and energy efficiency
- ▶ Applicable to multiple molten metal heating operations
- ▶ Uses about 30% of energy input required by conventional gas-fired melters
- ▶ Zero in-plant emissions

Ceramic Membranes for Gas Separation

Low-cost, robust membrane allows economical recovery of industrial gases



Ceramic membranes are very robust and can perform a variety of separations, but high costs have limited their

industrial applications. Media and Process Technologies has overcome the cost barrier by developing a new inexpensive ceramic membrane base layer which supports a gas-specific inorganic thin film layer. The ceramic membrane eliminates the cooling step that is typically required prior to industrial gas separations, resulting in significant energy savings. The targeted applications include hydrogen production, landfill gas recovery, and CO₂ removal in natural gas processing.

Contact:

Paul Liu
Media and Process Technology, Inc.
(412) 826-3711
pliu@mediaandprocess.com

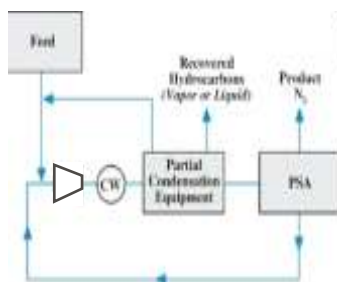


Benefits:

- ▶ Reduces energy consumed in gas separation
- ▶ Simplifies gas production processes

Pressure Swing Adsorption for Hydrocarbon and Nitrogen Recovery

Highly selective pressure swing adsorption technology recovers valuable components from waste streams



Many polyolefin plants use nitrogen to strip unreacted monomer and other additives from the product polymer. This gaseous waste stream is typically flared, but pressure swing adsorption enables the recovery of the nitrogen, monomer, and additives for reuse. A single unit operation, it delivers the lowest operating cost and the lowest emissions for polymer

degassing operations, while providing nitrogen with a hydrocarbon content as low as 500 ppm.

Contact:

Keith Ludwig
Air Products and Chemicals
(610) 481-5700
ludwigka@apci.com



Benefits:

- ▶ 100% recovery of N₂ and hydrocarbons
- ▶ Annual savings of 81.5 billion Btu

Three units in operation

TruePeak Process Laser Analyser

In situ measurement for chemical process control



Current chemical process control uses few in situ sensors, relying instead on analytic techniques that require sample conditioning and transport, and significant turnaround time. In situ sensors

can provide real-time measurements, enabling better understanding and control of the process and improving process optimization, product quality, and plant economics. The TruePeak sensor is a tunable diode laser analyzer that directly measures the concentration of O₂, H₂O, and potentially several other gasses. The rugged unit is capable of providing real-time, accurate measurements in harsh environments and can be used in a variety of chemical process applications.

Contact:

Don Wyatt
Analytical Specialties
(281) 488-0409
dwyatt@analyzer.com

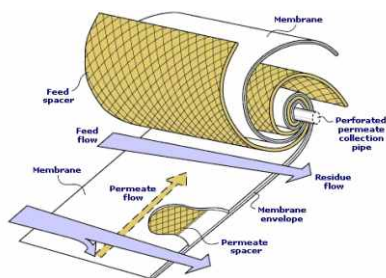


Benefits:

- ▶ Fast response time
- ▶ Suitable for processes up to 1500°C and 20 bar
- ▶ Interference free

VaporSep®: Solvent Recovery from Effluent Streams

Membrane separation used for economical recovery of industrial solvents



The VaporSep® system uses selectively permeable membranes to separate volatile organic compounds (VOCs) from gaseous waste streams. This system is being used for waste gas treatment in petrochemical and pharmaceutical industries, and has many more applications in

recovering CFCs, olefins, refrigerants, and other solvents. In addition, the advantage of recovering feedstock and diverting it from the waste stream, the membrane system is a simple, reliable, and energy efficient technology.

Contact:

Hans Wijmans
Membrane Technology and Research, Inc.
(650) 328-2228 ext. 1118
wijmans@mtrinc.com



Benefits:

- Recovery efficiency of 99% for VOCs
- Saves material costs through the recovery of solvents and process chemicals
- Reduces chemical releases to the environment

Over 100 systems in operation

**Chemical Engineering Magazine's
Kirkpatrick Achievement Award**

Aqueous Cleaner and CleanRinse™ Recycling System

Low cost recycling system reduces waste in aqueous cleaning operations



The CleanRinse™ system is a simple mini-reactor system that chemically converts organic oily contaminants into surfactants and emulsifiers. This conversion increases the cleaning solution's ability to remove oil, grease, and dirt. The system regenerates the cleaning solution on site, allowing companies using this technology to produce less waste water and often decrease the cleaning time required.

Contact:

Mike McGinness
Ecoshield Environmental Systems Inc.
(713) 910-1919
ecomike@ecoshieldenv.com



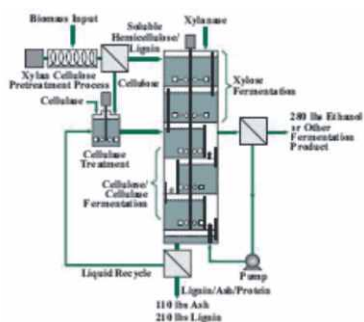
Benefits:

- Reduces energy use up to 50-75%
- Reduces hazardous waste disposal costs by 95%
- Low operating costs
- Increases productivity

**5 systems in operation or undergoing
performance testing**

Continuous Cascade Fermentation System for Chemical Precursors

Low-energy system converts food processing waste to useful chemicals



This fermentation technology enables the continuous processing of waste carbohydrates or other biomass feedstocks. The technology dramatically increases throughput by incorporating a proprietary cascade reactor design, maintaining a high cell density in the reactors, and uses highly flocculent yeast to speed

reactions. Industrial firms can utilize this technology to produce ethanol or other chemical precursors.

Contact:

Clark Dale
Bio-Process Innovation
(765) 746-2100
bpidale@bpidale.cnc.net

BPI

Benefits:

- Increased productivity
- Lower production costs

1 current installation

CoFlo™: Innovative Concurrent Distillation Process

New distillation trays improve performance and energy efficiency of separations



The CoFlo™ distillation tray significantly increases vapor and liquid handling without sacrificing separation efficiency. In concurrent distillation, the upward flowing vapor atomizes liquid in a tray and carries it up to collectors in the tray above. There the liquid is separated and sent back down via a side downcomer. This design distributes vapor and liquid more evenly and can increase column capacity by up to 100

percent over the conventional sieve tray arrangement.

Contact:

Bill Trutna
CoFlo, LLC
(512) 261-8317
wtrutna@austin.rr.com

Frank Seibert
CoFlo, LLC
(512) 471-7063
fseibert@mail.utexas.edu

Benefits:

- ▶ Allows column capacity increases of up to 100%
- ▶ Energy savings of 10%
- ▶ Reduces distillation column cost by 33%

CoFlo, LLC
Innovative Products

Improved Production of Corn-Based Polylactide (PLA)

Renewable plastic resins can replace petroleum-derived thermoplastics

Polylactide (PLA) is a polymer derived from renewable biomass feedstocks that can be used to produce packaging, food serveware, film, and fibers for fabric and carpeting. PLA matches or exceeds the performance of other petroleum-based plastics, but

requires less energy to produce. ITP-funded research on the fundamental structure-property relationships of PLA resulted in two new processing technologies. By enhancing the production process, these technologies improved the polymer properties, lowered production costs, and furthered PLA's commercial adoption.



Contact:

Robert Kean
NatureWorks LLC
(952) 742-0618
robert_kean1@natureworkslc.com

Benefits:

- ▶ Requires 20-50% less fossil fuel energy to produce
- ▶ Reduces CO₂ emissions
- ▶ Uses a renewable feedstock

A 300 million pound/year capacity plant in operation



Solution Crystallization Modeling Tools

Software aids design and optimization of crystallization processes



Crystallization is the most widely used separation and purification process in the chemical and pharmaceutical industry for products that are solids at room temperature and pressure. This set of crystallization software includes a mixed-solvent electrolyte model for predicting

solubility, a tool for simulating crystal size distribution, and software integrating electrolyte and crystallization tools with Fluent's computational fluid dynamics code.

Contact:

Andre Anderko
OLI Systems, Inc.
(973) 539-4996 ext. 25
aanderko@olisystems.com

Lewis Collins
Fluent
(603) 643-2600
rlc@fluent.com

Benefits:

- ▶ Improves product quality in terms of crystal size purity
- ▶ Reduces losses, rework, and downtime
- ▶ Shortens new product development time



*55 commercial licenses of OLI Systems
crystallization software*

Methane de-NO_x® Reburn Process

Award-winning technology enhances combustion and reduces NO_x formation in stoker boilers



Methane de-NO_x® is a retrofit reburning process that improves solid waste fuel combustion while controlling NO_x and CO emissions. The process injects natural gas above the stoker boiler grate and uses flue gas recirculation to enhance mixing and create an oxygen-deficient

atmosphere that retards NO_x formation. Overfire air is injected higher in the furnace to burn out the combustibles. This technology has been demonstrated on municipal solid waste-, coal-, and wood-waste/biomass-fired stoker boilers.

Contact:

Roger Glickert
Energy Systems Associates
(412) 429-3576
rglickert@energysystemsassoc.com



Benefits:

- ▶ Reduces NO_x emissions 50-70%
- ▶ Decreases natural gas use
- ▶ Increases waste fuel fire capacity

R&D 100 Award

Japan's Environmental Agency's
Environmental Prize

AF&PA Environmental and Energy
Achievement Award

Pressurized Ozone/Ultra-filtration Membrane System for TDS Removal

Novel filtration system enables closed-loop operation to cut energy and water use



A new technology combining pressurized ozone injection and ultrafiltration removes dissolved solids from paper mill process water, enabling cost-effective and efficient closed-loop operation. Ozone injection increases the oxidation of organic and inorganic total dissolved solids (TDS). These

solids precipitate out of the process water as large particles and are removed by ultrafiltration or nanofiltration membranes. The process water can then be reused, eliminating the need to heat fresh water.

Contact:

Peter James Rudy
Cellulose Products and Services
pjriudy@wyman.org

Benefits:

- ▶ Saves 333 billion Btu/year
- ▶ Removes 97.5% of total suspended solids
- ▶ Removes up to 50% TDS in one pass

PyrOptix Detection and Control of Deposition on Pendant Tubes

Infrared camera enables internal inspection of kraft recovery boilers during normal operation



The PyrOptix infrared camera system enables on-line detection of deposits, blockages, hot spots, and fixture damage in kraft recovery boilers. Without shutting down the boiler, the camera produces clear, thermal images and videos of boiler depths up to 100 feet. PyrOptix enables immediate response and

trend analysis for system optimization in high-temperature, particle laden environments. A sootblower control system integrated with the camera is in the development process.

Contact:

Stewart Boyd
Enertechnix, Inc.
(206) 322-4011
Stewart.b@enertechnix.com

Enertechnix[®]
Innovative Process Solutions

Benefits:

- ▶ Reduces sootblowing steam by 20%
- ▶ Reduces shutdowns
- ▶ Improves boiler safety

Over 40 systems sold to pulp and paper industry and other industries

Chemical for Increasing Wood Pulping Yield: ChemStone OAE® -11

Easy-to-handle additive improves quality and yield in all chemical pulping processes



ChemStone OAE® -11 thoroughly penetrates dense wood chips and protects fine fibers from overprocessing. This novel pulping additive's unique chemistry increases alkali penetration by 30% within 15 minutes, but halts acid hydrolysis upon alkali availability to prevent overcooking. Unwanted compounds are prevented from re-precipitating, and by-products are effectively eliminated from the fiber mixture. This cooking aid is effective for hardwood and softwood pulps and applicable to all pulping processes.

Contact:

Mike Blackstone
ChemStone, Inc.
(864) 458-8077
mblackstone@chemstone.com



CHEMSTONE, INC.

Benefits:

- ▶ Saves 125,000 Btu per ton pulp
- ▶ Increases pulp yield 4-5%
- ▶ Decreases bleaching chemical use

8 million tons of pulp processed with ChemStone OAE® -11 in 2004

VOC Reduction in Wood Drying

Operational practices can reduce volatile organic compounds (VOCs)



A long-term effort co-funded by industry (principally Georgia-Pacific Corporation) developed techniques reducing VOCs emitted during wood drying and pressing. These techniques optimize wood moisture control to prevent fines from overdrying and resultant VOC production. By

controlling fines generation, manufacturers improve wood quality while reducing VOC production and energy-associated control costs.

Contact:

Sujit Banerjee
Institute of Paper Science and Technology at Georgia Tech
(404) 894-9709
Sujit.banerjee@ipst.edu



Benefits:

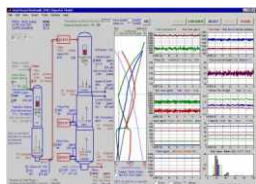
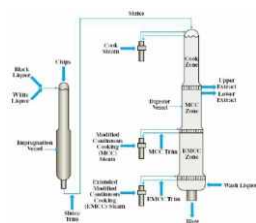
- ▶ Saved \$28 million at Georgia-Pacific
- ▶ Saved \$200,000 annually at Norbord's Guntown, MS mill
- ▶ Reduces energy and control costs
- ▶ Controls VOC emissions and wood waste

2000 American Forest & Paper Association Environmental Award

2000 Environmental Award from the Governor of Maine

Dynamic Simulation Model for Continuous Digesters

Process model improves continuous digester performance for hardwood and softwood



This PC-based model predicts the dynamic behavior of the continuous digester, including internal operating characteristics throughout the column. The model runs about 300 times faster than real-time and includes a graphical user interface. The simulation software is suitable for designing control systems, improving operating policies (including grade transitions and production rate changes), and training operators. Customized implementation service is provided for each digester.

Contact:

Ferhan Kayihan
IETEK, Integrated Engineering Technologies
(253) 925-2179
fkayihan@ietek.net



Benefits:

- ▶ Saves 125,000 Btu/ton processed wood chips
- ▶ Increases yield 4-5%
- ▶ Reduces emissions and effluents

Thermodyne™ Evaporator: A Molded Pulp Products Dryer

Innovative technology enables faster, cleaner, safer drying of molded pulp products



This energy-efficient dryer uses superheated steam and oxygen suppression to improve molded pulp product drying. As water evaporates from the product, the vapor is superheated by indirect integral heaters, raising the temperature within the dryer.

This allows faster drying at lower temperatures than conventional air dryers. In addition, volatile organic compounds (VOCs) are recovered by the condensate. The dryer is suitable for manufacturing molded fiber particles and drying pulp and wood veneer products.

Contact:

Donald P. Curry
Merrill Air Engineers
(207) 767-1223
curry.don@verizon.net



Benefits:

- Reduces energy use by 50%
- Lowers production costs
- Reduces scorching, burning, and discoloration of molded pulp products

XTREME™ Cleaner: Removal of Light Sticky Contaminants

High-capacity, efficient cleaning of post-consumer paper prior to recycling



The XTREME™ Cleaner is a centrifugal cleaning technology that effectively removes "stickies," wax, polyethylene, binding glue, and other contaminants from post-consumer fiber sources. This long-residence-time, small-diameter cleaner's improved kneading and vortex separation technology

effectively separates tiny contaminants that are close to the specific gravity of the fiber itself. Paper mills using this technology can use lower-cost furnish without lowering paper quality.

Contact:

Carol Costello
Kadant Black Clawson, Inc.
(513) 229-8100
info@kadantbc.com



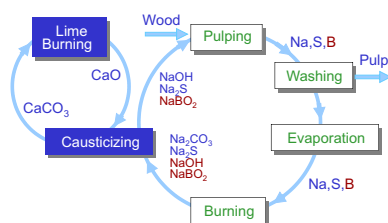
Benefits:

- Reduces energy use by 50%
- Saves \$3,500-11,000/day
- Reduces paper breaks by 40-60%

27 systems in operation

Borate Autocauticizing

Chemical addition increases pulp mill causticizing capacity and pulp production



Pulp mills can use partial borate autocauticizing to increase their causticizing capacity or reduce energy intensity by adding sodium metaborate to the liquor cycle which drives autocauticizing reactions

in the recovery boiler and forms sodium hydroxide in the smelt dissolving tank without the use of lime or additional causticizing processes (see diagram). Full autocauticizing is under development to utilize the entire causticizing requirement and eliminate lime recausticizing and calcining processes.

Contact:

Saied Kochesfahani
U.S. Borax, Inc.
(661) 287-5400
Saied.kochesfahani@borax.com



Benefits:

- Increases causticizing capacity and pulp production
- Reduce lime purchase and recausticizing load
- Reduces lime kiln load and energy requirement

Screenable, Pressure-Sensitive Adhesives for EnviroSensitive™ Labels

Novel adhesive facilitates recycling of paper labels



EnviroSensitive™ Labels utilize a unique pressure-sensitive (PSA) that is easily removed from recovered paper during the recycling process. This adhesive forms larger adhesive particles during repulping, enhancing its removal during screening while reducing or eliminating the adhesive's impact on the recycling process. This new, environmentally benign PSA allows recyclers to repulp a wider variety of waste paper and reduce

processing backups. The adhesive has "quick-stick" permanence and is available only on EnviroSensitive™ Labels.

Contact:

Deb Ashton
Avery Dennison
(800) 777-2879 ext. 300
deb.ashton@averydennison.com



Benefits:

- ▶ Maintains excellent strength and adhesive properties
- ▶ Improves energy efficiency of recycled papermaking
- ▶ Reduces equipment downtime
- ▶ Lowers fiber loss and chemical costs

MultiWave™ Automated Sorting System for Efficient Recycling

High speed scanning system features improved lignin sensor



The MultiWave™ sensor is a paper and plastic sorting system that incorporates an innovative lignin sensor originally developed through North Carolina State University-led R&D. The lignin sensor effectively detects the presence of paper in a waste stream conveyed at high

speeds by measuring the lignin's fluorescence under green light. Based on the sensor data, the master computer then fires compressed air jets to eliminate rejected materials. The lignin sensor enables the MultiWave™ system to scan more than 160 ft² per second in machine widths up to 96 inches, significantly increasing throughput rates.

Contact:

Michael Grubbs
MSS Inc.
(615) 781-2669
info@magsep.com



Benefits:

- ▶ Increases throughput rates
- ▶ Enhanced sorting and ejection accuracy
- ▶ Conveys up to 15 tons per hour

Four units in operation

ChemStone RBS400

Yield-enhancing additive reduces scaling in pulping equipment



ChemStone RBS400 increases circulation flow in pulping equipment by reducing scale build-up and plugging. Based on a new, patent-pending polymeric phosphonate, this digester additive controls the metals that interfere with bleaching and with the sulfur chemistry of a kraft cook. The chemical also reduces dichloromethane (DCM) extractives by controlling calcium before it can react with fatty and resin acids. Even fouled digesters and evaporators can be cleaned with just a 1 lb/ton dose.

Contact:

Mike Blackstone
ChemStone, Inc.
(864) 458-8077
mblackstone@chemstone.com



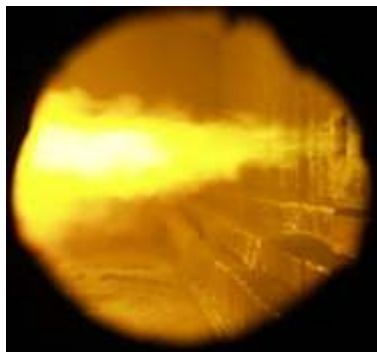
CHEMSTONE, INC.

Benefits:

- ▶ Increases Southern hardwood yield by 3%; over 5% when used with ChemStone OAE®-11
- ▶ Minimizes downtime needed for cleaning calcium scales
- ▶ Controls calcium levels and reduces DCM extractives

Oxy-Fuel Firing

Oxy-fuel combustion saves energy and reduces emissions



Oxy-fuel firing uses oxygen instead of air in the high-temperature combustion process employed in glass melting furnaces. Burners specifically designed for oxy-fuel firing are employed to provide maximum efficiencies. Oxygen is provided to glass manufacturers by one of three primary technologies, depending on the economics for each glass facility.

Glass manufacturers are using this process in all major glass sectors.

Contact:

Kevin Lieve
Air Products and Chemicals
(610) 481-7007
lievreka@apci.com



Eric Streicher
American Air Liquide
(713) 896-2330
eric.streicher@airliquide.com



Neil Simpson
BOC Gases
(908) 771-1667
neil.simpson@boc.com



Frank Dumoulin
Praxair, Inc.
(203) 837-2676
frank_dumoulin@praxair.com



Benefits:

- ▶ Reduced fuel use by 15-45%
- ▶ Reduced NO_x emissions up to 90%
- ▶ Increased production rates

Approximately 100 units operating
in the United States

PrimeFire 400: High-Luminosity, Low-NO_x Burner

High-efficiency burner lowers cost and emissions in oxy-fuel glass melters



The PrimeFire 400 is an advanced flat flame burner designed for oxy-fuel glass furnaces which can be fitted into existing control schemes. This burner improves performance by modifying the fuel prior to combustion and then forming and

burning soot in the flame. The PrimeFire 400 comes in four sizes with maximum capacities of 2MM, 4MM, 10MM and 20MM Btu/hr. All models can be fired using natural gas or fuel oil. Glass companies employing oxy-fuel glass furnaces can utilize this technology.

Contact:

Kevin Cook
Eclipse, Inc.
(407) 628-3338 ext. 171
kcook@eclipsenet.com



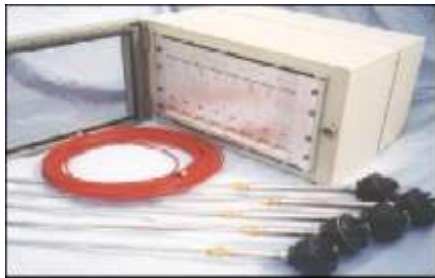
Benefits:

- ▶ Thermal efficiency increases up to 20%
- ▶ Reduces NO_x by up to 50%
- ▶ Extends furnace life

Operating in 2 U.S. plants

Advanced Temperature Measurement System

New materials leads to development of improved monitoring equipment



This temperature measurement system uses a calibration reference matrix built into the sensor and an associated remote signal processor and signal analysis software. A proprietary dielectric material used in the sensor

helps avoid the normal failure mechanisms of other sensors. The sensor system performs real-time signal processing of the matrix data to provide accuracy in sensor readings. Glass manufacturers can use this sensor in their high-temperature melting furnaces.

Contact:

Bernard Conner
AccuTru International Corp.
(281) 358-5743
bconner@accutru.com

AccuTru International

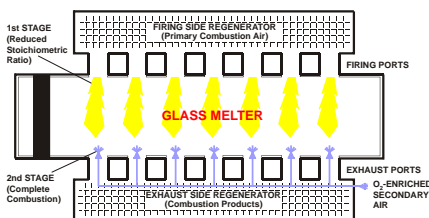
Benefits:

- ▶ Improved fuel efficiency
- ▶ Improved process yield
- ▶ Extended equipment life

30 units operating in the United States

Oxygen-Enriched Air Staging

NO_x emissions reduced for glass furnaces



This technique controls NO_x formation and improves heat transfer in air-gas glass furnaces without interrupting furnace operation or adversely affecting product

quality. The system stages combustion by holding back a portion of the combustion air normally provided during the earliest stages of combustion and flame development. The resulting flame is hotter and more luminous. Glass manufacturers can employ this technique in existing endport and sideport regenerative glass furnaces.

Contact:

Kevin Cook
Eclipse, Inc.
(407) 628-3338 ext. 171
kcook@eclipsenet.com

ECLIPSE
Innovative Thermal Solutions

Benefits:

- ▶ NO_x levels reduced 40-70%
- ▶ Cost-effective method to meet emission reductions

5 units operating in the United States

R&D 100 Award Winner

Meta-Lax® Thermal Stress Reliever

Quick, energy-efficient vibration technology prevents distortion and cracking



The Meta-Lax® process relieves thermal stress within metal components by using nondestructive, highly efficient sub-harmonic vibrations to prevent distortion and cracking. Meta-Lax, short for "metal relaxation," is a proven substitute for 80% to 90% of heat-treatment stress relief in metal working

applications. It improves the inconsistencies of the previous resonant-vibration technology by using more efficient, more consistent "sub-harmonic" vibrational energy, which is the optimum vibration stress-relief frequency. The system has no size or weight limitations, and the technology can be applied to most metals.

Contact:

Thomas Hebel
Bonal Technologies, Inc.
(800) 638-2529
info@bonal.com



Benefits:

- ▶ Reduces energy consumption by 98%
- ▶ Reduces process time and costs 65-98%
- ▶ Prevents weld distortion and cracking 50-95%
- ▶ Reduces scrap up to 100%

1,200 systems in operation

Multiple-Station Air Gauge: Non-Contact Part Inspection and Gauging

Air gauge system accurately gauges parts without damaging casting patterns



The multiple-station air gauge system allows precise non-contact measurement of low-modulus materials during the casting process without damaging casting patterns. The system works by blowing air on surfaces and monitoring the pressure ratios created by airflows between a central primary

air chamber and 30 separate secondary chambers. The system reduces processing time, product reject rate and scrap generation, thereby increasing the energy efficiency of the casting process.

Contact:

Brian Backus
Delaware Machinery and Tool
(765) 284-3335
bbackus@delawaremachinery.com



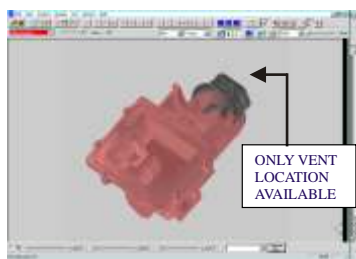
Benefits:

- ▶ Takes 30 measurements in less than 1 minute
- ▶ Accurate within 0.0005 inch

System was used to determine standards for EPS Shrink Rates

CastView™ Modeling Program: Die Casting Design Visualization

Quick evaluation of die casting design during the design phase



CastView™ is a PC-based modeling program that simulates molten metal and heat flow in the die casting process, allowing designers to detect potential diecasting problems during the design phase. This easy-to-use program utilizes imported STL

files to create detailed simulations in minutes of die cavity filling and thermal distribution. CastView™ can reduce scrap by 20% or more, resulting in increased yield and saving the energy formerly wasted by producing defective parts.

Contact:

Publications Department
North American Die Casting Association
(847) 279-0001
www.diecasting.org



Benefits:

- ▶ Fewer die iterations
- ▶ Better casting designs and better running dies

123 units sold

Ceramic Composite for Metal Casting

New material produces superior, affordable dies



A new ceramic composite in the nitride/nitridecarbide family provides stability to molten metals and are resistant to corrosion, oxidation, thermal fatigue, and cracking. As an alternative to conventional forming dies, lower-cost hybrid composites have the potential

to last up to 10 times longer than coated steel dies with significantly lower weight. The ceramic dies also produce fewer casting rejections, thereby reducing the energy needed to recycle the rejected castings.

Contact:

Dr. J.C. Withers
Materials and Electrochemical
Research Corporation
(520) 574-1980
jcwiters@mercorp.com



Benefits:

- ▶ 5-10 times longer die life
- ▶ 2-5 times harder than tool steels

Installed in several U.S. locations

SeeFOAM-CPFD™: CFD Software for Lost Foam Pattern Blowing

Software package allows engineers to detect potential filling problems before cutting tooling



A foundry engineering software package correctly models fill patterns, visualizes the effects of vent locations and fill gun parameters, and provides final local

pattern density. Using Computational Particle Fluid Dynamics (CPFD), the software models white expanded polystyrene (EPS) patterns while monitoring any significant interaction between the individual EPS bead motion and air flow. This user-friendly software package gives engineers the ability to detect pattern defects before a tooling is produced or filled, saving costs with improved tooling designs.

Contact:

Peter Blaser
Arena-flow, LLC
(505) 275-3849
info@arena-flow.com

Arena-flow®

Benefits:

- ▶ Accurately predicts location and causes of foam pattern defects
- ▶ Optimizes fill gun parameters and vent locations
- ▶ Creates foam patterns with consistent density and permeability
- ▶ Saves tooling production costs, reduces scrap

Validated by automobile manufacturers
in the U.S. and Japan

Rapid Solidification Process (RSP) Tooling: Quality Mold Production

Simple, more efficient tooling for multiple industries



Spray Process

The Rapid Solidification Process (RSP) was developed to improve the efficiency of manufacturing molds and dies. RSP Tooling uses a system that is able to spray molten steel onto a ceramic negative, while spinning and changing the spray angle for even distribution. RSP allows production-quality tooling for steel, glass, metal casting, forging and heat treating applications to be

made in a fraction of the time and at a significantly reduced cost compared to conventional tool-making practices.

Contact:

James R. Knirsch
RSP Tooling, LLC
(440) 505-6033
knirsch@rsptooling.com



Benefits:

- ▶ Saves 50% of additional insert cost
- ▶ Increases tool hardness
- ▶ Extends tool lifetime

2001 FLC Award
2000 DOE Energy@23 Award
1998 R&D 100 Award

RIM™ Radio-Imaging Method: Imaging Ahead of Mining

Precise identification of cleaner, more complex coal beds



The RIM™ Radio-Imaging Method uses wireless synchronization between a transmitter and remote imaging receiver to produce images of coal seams. RIM™ sends an electromagnetic wave through the subject area, detects differences in conductivity between coal and surrounding materials, and produces images of the geological strata. This information is used

to produce an image that maps the mine's geological features for targeted mining. RIM™ applications include metalliferous mining, environmental research, and civil engineering.

Contact:

Joseph Duncan
Stolar Horizon, Inc.
(505) 445-3607
jtd@stolarhorizons.com



Benefits:

- ▶ Longwall mapping—finds geological hazards
- ▶ Predicts coal and ore thickness and trends
- ▶ Detects and maps old mine voids

Used in 5 mines through 2003
2004 R&D 100 Award Winner

Wireless Telemetry for Mine Monitoring and Emergency Communications

Cell based technology improves safety, efficiency, and mining costs



A wireless, through-the-earth telemetry system uses ComCell technology and allows mine workers to communicate underground or with personnel in aboveground structures. This system can be programmed for data transmission or equipped with

two-way wireless radios for voice transmission. Unlike conventional equipment, this technology provides uninterrupted voice signals and is reliable during emergency situations. This system increases underground mine safety and reduces downtime costs associated with broken communication.

Contact:

Robert Nigrini
Transtek, Inc.
(412) 799-0315
r.nigrini@worldnet.att.net



Benefits:

- ▶ Increases safety of coal mining operations
- ▶ Potentially improves mining forecasting by 10%
- ▶ Streamlines communication among underground workers and to the surface
- ▶ Suitable for transmitting production data and environmental monitoring data

30-40 units in use in U.S. mines

Smart Screen Systems Model S3i-102B

A new smart screening technology will increase energy efficiency and throughput



Smart Screens use small electromagnetic motors with a closed-loop power management system to cause *only* the "live" screening deck to vibrate at natural frequency. This approach is replacing conventional screens that use the brute force of a large electric motor and eccentric-shaft

to mechanically shake the entire machine. Smart Screen Systems provide fine mineral separations for the mining industry and is currently developing applications for construction, pharmaceutical, agriculture, and petroleum industries.

Contact:

Jesse Huset
Smart Screen Systems, Inc.
(952) 556-5205
jhuset@smartscreensystems.com



Benefits:

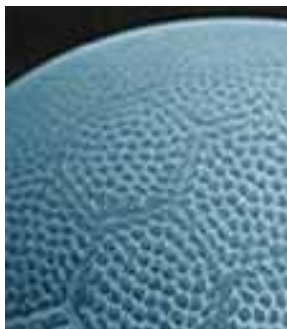
- ▶ Increases capacity and efficiency
- ▶ Reduces energy consumption by 50-70%
- ▶ Lowers maintenance and eliminates lubrication – no shafts, bearings, bushings, or other moving parts
- ▶ Decreases excess noise and vibration to improve worker safety

2004 R&D 100 Award

2002 Smart Structures Product
Implementation (SPIE) Award

Fibrous Monolith (FM) Composites: Wear-Resistant Components

Improving cost/performance ratio of mining and drilling equipment



Fibrous monolith (FM) composites are a new class of structural ceramics exhibiting very high fracture energies and damage tolerance. Ceramic and/or metal powders are blended with thermoplastic polymer binders and then co-extruded to form a 'green' fiber. The green fiber composite may then be wound, woven, or braided into the shape of the desired component. FMs have been demonstrated in roller cone bit

inserts and other wear resistant components for drilling, earth-moving, and crushing equipment.

Contact:

Ken Knittel
Advanced Ceramics Research
(520) 434-6316
kknittel@actucson.com



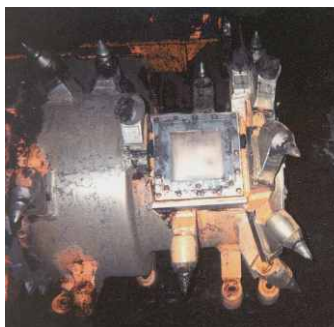
Benefits:

- ▶ Reduces downtime and energy consumption
- ▶ Potential 300% increase in equipment performance

2002 R&D 100 Award

Horizon Sensor™: Efficient Extraction of Higher Quality Coal

Computer-based technology profiles different layers of coal



The Horizon Sensor™ uses resonant microstrip patch antenna impedance to characterize different layers of coal. The sensor, located on the mining machine inches from the cutting bits, reads the impedance data, which varies by uncut-coal thickness. The mining machine receives the impedance data as radio waves via the computer

system and displays a color-coded image of the strata enabling miners to find clean coal, direct the cutting machine accordingly, and mine more efficiently.

Contact:

Jerry Jones
Stolar Horizon, Inc.
(505) 445-3607
jjones@stolarhorizons.com



Benefits:

- ▶ Identifies cleaner coal
- ▶ Improves mining forecasting by 10%, up to 1,800 feet

2002 R&D 100 Award
Used in 7 U.S. mines

Belt Vision Inspection System for Improving Mining Productivity

Low-cost, comprehensive inspection system identifies defects and reduces downtime



The Belt Vision system uses a camera and computer system to monitor mechanical splice deterioration in conveyor belts while in operation in

underground and surface mines. The computer system, located on the belt or on a remote desktop, digitizes and records continuous imaging of the belt and splices. Mine personnel using this system can review live or historical images several times a day with minimal effort and take action before belt splices fail.

Contact:

Titus Beitzel or Rick Bray
Beitzel Corporation
(301) 245-4107
titusbeitzel@beitzelcorp.com
rickbray@beitzelcorp.com



Benefits:

- Reduces belt downtime and energy consumption
- Promotes better maintenance scheduling
- Improves belt availability and mine productivity

12 units in operation

Novel Dry Coal Deshaling Mobile Unit

Easy-to-use system provides efficient coal cleaning at the mine site



A new dry deshaling technology removes materials with high-ash content prior to loading and further coal cleaning. This coal cleaning unit provides high-density (2.0 specific gravity) separation near the extraction point or working face of a mining operation. The system requires little to no water, facilitating easier product transportation and

waste material hauling. These features enable mine personnel to remove waste rock while minimizing coal losses to the rejection stream.

Contact:

Vince Richardson
Eriez Manufacturing Company
(814) 835-6000
vrichardson@eriez.com



Benefits:

- Reduces deshaling energy consumption and downstream electrical requirements
- Decreases disposal costs and diesel consumption
- Low capital and operating costs
- Reduces land impacts and waste emissions

Ammonia Absorption Refrigeration Unit for Refinery Operations

Waste heat-powered technology recovers fuel, increases refinery capacity



An advanced ammonia refrigeration unit recovers gasoline and liquefied petroleum gas (LPG) from refinery fuel gas header streams. This waste heat-powered technology cools the waste stream, causing the condensation of valuable liquid products that would otherwise

remain in the stream. In addition, this technology raises the column capacity of fluid catalytic crackers by reducing the burden of overloaded wet-gas compressors. This technology is also applicable to mainstream industrial refrigeration operations.

Contact:

Donald Erickson
Energy Concepts Co.
(410) 266-6521
enerconcep@aol.com

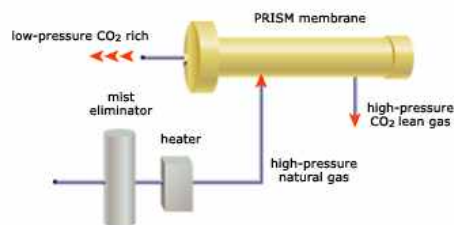
Energy Concepts

Benefits:

- Delivers temperatures as low as -50°F
- 2-year payback time
- Decreases annual CO₂ emissions
- Increases refinery throughput

PRISM® Membrane Technology for Natural Gas Cleaning

Effective, low-cost removal of CO₂ and H₂S from natural gas



The PRISM® membrane separation technology converts sub-quality natural gas into pipeline-grade gas by removing impurities, such as CO₂ and H₂S. The

highly selective membrane system separates gases based on relative permeation rates, enabling stand-alone or synergistic separations processes. This system can be used as a bulk-removal device, or it can replace/minimize the size of traditional amine systems. The membranes' compact size and tolerance to particular contaminants and water make them suitable for offshore and remote applications.

Contact:

Charles Page
Air Products & Chemicals
(800) 635-8842
pagect@airproducts.com

AIR PRODUCTS

Benefits:

- Reduces system size and weight by 40%
- Low initial capital costs
- Reduces downtime and maintenance costs

Mesabi Nugget Cokeless Ironmaking

High quality, low cost iron nugget production



The Mesabi Nugget cokeless ironmaking technology optimizes the ITmk3® process, which turns iron ores into high quality iron nuggets in a rotary hearth furnace. The technology is able to complete reduction, melting, and slag removal in only about ten minutes. The pilot plant produced 9500 metric tons of iron nuggets

superior in quality to direct reduced iron (DRI) and similar to blast furnace pig iron. The product can be used as a supplemental iron source in electric arc furnaces, basic oxygen furnaces (BOF), and metal castings.

Contact:

Larry Lehtinen
Mesabi Nugget, LLC
(218) 226-6206
llehtinen@cci-northshore.com



Nick Kobayashi
Midrex Technologies, Inc.
(704) 378-3358
nkobayashi@midrex.com

MIDREX

Benefits:

- ▶ Produces nuggets of 96-98% nugget purity
- ▶ Reduces energy use by 30%
- ▶ Reduces emissions by over 40%

Laser Contouring System (LCS): Extending the Lifetime of BOF Refractory Lining

Accurate 3-D measurements of furnace and ladle interiors



The Laser Contouring System (LCS) is a high-speed, laser-based tool that measures the thickness of refractory bricks lining basic oxygen furnaces (BOFs) and ladles. The LCS provides highly accurate 3-D measurements of the entire vessel's lining thickness in minutes. Quick, on-line feedback eliminates downtime and costs due to off-line inspection and unnecessary relining. Steelmakers using this system can extend equipment lifetime while ensuring operational safety.

Contact:

Michel Bonin
Process Metrix, LLC
(925) 460-0385 ext. 112
mbonin@processmetrix.com



Benefits:

- ▶ Provides rapid, accurate measurements of refractory lining thickness
- ▶ Optimizes the relining frequency
- ▶ Reduces furnace downtime and associated loss of production

Customized for each installation

Nickel Aluminide Transfer Rolls

High-strength rolls resist sagging and oxidation at high temperatures



High-strength and wear-resistant nickel aluminide rolls reduce shutdowns and maintenance operations in industrial annealing systems. The nickel aluminide alloys rolls provide greater high-

temperature strength and wear resistance compared to the conventional H series alloys currently used. These aluminide rolls enable straight-through plate processing and could enable additional processing of other surface-critical materials.

Contact:

Roman Pankiw
Duraloy Technologies, Inc.
(724) 887-5100
techmgr@duraloy.com



Benefits:

- ▶ Roll lifetime exceeds 3 years of nearly continuous use in plate mill annealing
- ▶ 30% energy savings per annealed plate
- ▶ Reduces shutdowns and maintenance operations

Over 150 plate furnace rolls in operation

Dilute Oxygen Combustion (DOC) System

Improving reheat furnace productivity while reducing NO_x emissions



The Praxair® Dilute Oxygen Combustion (DOC) system injects fuel gas and oxygen through separate high-velocity jets, allowing the gases to heat up before mixing together. This prevents high peak flame temperatures that generate NO_x. The diffuse flame heats the steel more uniformly and uses less

fuel than air injection. Though installation is simple and inexpensive, the technology vastly improves rolling mill yields and efficiency.

Contact:

Ian Masterson
Praxair, Inc.
(317) 713-2820
ian_masterson@praxair.com



Benefits:

- Reduces fuel use by 50%, approximately 1 million Btu/ton
- Increases furnace productivity 10-30%
- Lower capital and operating costs

Suitable for steel reheating, non-ferrous smelting applications

Zinc Removal from Galvanized Steel Scrap: Increasing Scrap Value

Recover zinc pollutant for reuse



Zinc removal of galvanized steel scrap is a multi-stage process that produces a zinc-free steel scrap and a zinc byproduct. Hot caustic dissolves the zinc coating that is on the shredded scrap. Subsequent process stages clean the steel and purify the zinc. This removal method converts the zinc from a

pollutant into salable byproduct. It also enhances the value of the steel scrap as a feedstock for steelmaking.

Contact:

Gunnar Skoog
Meretec Corporation
(219) 805-7075
gunnar.skoog@meretec.com



Benefits:

- Saves 11 million Btu/ton of scrap
- Yields 98% pure, salable metallic zinc
- Increases scrap recycling value through effective zinc removal

**One commercial scale
de-zincing plant in operation**

Now seeking licensees worldwide

INTEG Hot Strip Mill Model

Computer-based model predicts properties of hot mill products



The Hot Strip Mill Model (HSMM) is a PC-based, off-line model that simulates the steel rolling process and predicts final product properties. Users can easily configure mill settings, which the model then inputs to physical models to calculate thermal, flow stress, microstructure evolution, and final mechanical properties. These capabilities allow

mill operators to avoid costly industrial trials. The model can handle both strip and plate products for a variety of steel grades.

Contact:

Rick Shulkosky
INTEG process group, inc.
(877) 256-1823
rshulkosky@integpg.com



Benefits:

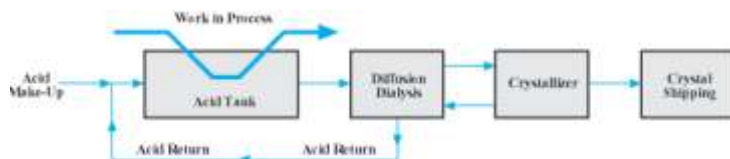
- ▶ Saves times and money
- ▶ Decreases product variability
- ▶ Accelerates product development

Free 30-day demo with full support for qualified users

Pickliq® Process for Recovering Acids and Metal Salts from Pickling Liquors

Low-energy technique enables cost efficient recovery

The Pickliq® process efficiently recovers pickling acids and saleable metal salts using a unique combination of membrane diffusion dialysis, heat interchange, and low-temperature crystallization technologies. This low-energy approach enables continuous operation and maintains optimum tank acid and iron concentrations. This process has improved process control and product quality for the steel fabrication industry, but could also benefit the metal finishing and circuit board industries.



Contact:

Douglas Olsen
Green Technology Group, Inc.
(845) 855-5468
greentg@verizon.net



Benefits:

- ▶ Improves productivity and quality control
- ▶ Reduces product rejections and rework
- ▶ Minimizes demand for virgin acids and neutralizing chemicals

Enables cost-efficient recovery for smaller facilities

Deep-Discharge Zinc-Bromine Battery Module

New battery increases load-leveling efficiency and reduces peak-power purchases



A new zinc-bromine battery (ZBB) increases load-leveling efficiency and offers longer cycle life with less weight. This 2MWh storage system is a flowing electrolyte battery that stores up to three times the amount of energy as

conventional storage batteries. In addition, the system features the unique capability of discharging down to zero voltage without degrading battery life. These features provide continuous and uninterrupted energy generation for energy utilities and industrial users during peak-power cycles and energy shortages.

Contact:

Robert Parry
ZBB Energy Corporation
(262) 253-9800
rparry@zbbenergy.com



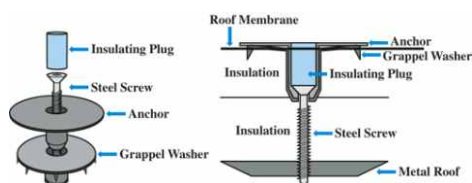
Benefits:

- Reduces manufacturing and disposal costs
- Simplifies temperature control by removing heat from stacks

Four units sold

RR-1 Insulating Screw Cap

New fastening system increases building energy efficiency



The corrosion-resistant RR-1 insulating screw cap is a simple but effective heat loss solution for commercial and

industrial buildings. This improved fastener consists of an injection-molded, polycarbonate alloy anchor, a soft insulating plug, and an optional grappel washer. The metal screw portion of the fastener is embedded at least one inch into the insulation board, reducing heat transfer through the fastener. This new design makes the fastener less likely to corrode or lose holding strength over time, ensuring long-lasting building protection.

Contact:

Robert Romine
The Romine Company
(740) 345-9144

Benefits:

- Improves corrosion resistance to prevent roof failures
- Reduces building energy costs
- Low installation costs; no pre-drilling required
- Rapid payback in both cold and humid climates

Approximately 300,000 units sold

Radiation-Stabilized Burner

High thermal efficiency and very low emissions of nitrogen oxides (NO_x) and carbon monoxide (CO) in industrial boilers and process heaters



The Pyromat CSB™ Radiation Stabilized Burner (RSB) exhibits improved performance thanks to full premixing of fuel and air, surface stabilization through the use of radiant zones and high flux zones on the burner surface, and controlled flame shape

above the burner surface. This results in low NO_x and CO emissions without sacrificing thermal efficiency or boiler reliability. RSB burners can achieve stable operation over a broad range of emissions levels, from sub-9 ppm NO_x to sub-30 ppm NO_x, with one burner design. The Pyromat CSB™ Radiation Stabilized Burner is available for commercial and industrial boilers, new and retrofit applications.

Contact:

Jim Gotterba
ALZETA Corporation
(800) 676-8281
jgotterba@alzeta.com



Benefits:

- ▶ Sub-9 ppm NO_x emissions
- ▶ Sub-50 ppm CO emission

Over 200 units sold

Callidus UltraBlue CUB Burner: Next Generation Burner Technology

Ultra-low emission, high efficiency burners help end users meet stringent environmental regulations



Callidus UltraBlue Burners combine three advanced technologies to achieve extremely low emission levels and maximize fired heater efficiencies, namely: ultra-low emission burner technology, an enhanced fired heater system, and an online temperature sensing and

burner control system. Callidus UltraBlue burners eliminate or reduce the need for expensive post-combustion emissions control equipment.

Contact:

Robert Cupp
Callidus Technologies, LLC
(918) 523-2241
rcupp@callidus.com



Benefits:

- ▶ Reduces thermal NO_x in the combustion zone by 80% to 90%
- ▶ Burner turndown ratio of at least 3:1
- ▶ No external flue gas recirculation or steam injection necessary

1,300 units have been sold to the petroleum industry alone

SpyroCor™ Radiant Tube Heater Inserts

Ceramic inserts' unique twisted design saves energy for metal heat-treating furnaces



SpyroCor™ inserts have a patented high surface area, multi-fin twist design that enables non-turbulent, high convection heat flow in radiant tube heaters. The burner leg of the heater transfers

heat to the insert via convection, and this energy is radiated by the insert to conserve heat in the furnace. As a result of even heat transfer, these ceramic inserts reduce heat loss in the exhaust leg, delivering more energy to the metal load and increasing throughput.

Contact:

Tom Briselden
Spin-Works, LLC
(814) 440-2604
tbriselden@spin-works.com

Benefits:

- ▶ Reduces heat loss in the exhaust leg by 15-20%
- ▶ Balances heat transfer between burner leg and exhaust leg
- ▶ Increases throughput at lower energy usage levels

Over 2,300 units sold in 2004

Forced Internal Recirculation Burner: Minimizes the Formation of Thermal and Prompt NO_x

Low emissions and high energy efficiency at low excess air levels



The Forced Internal Recirculation (FIR) burner combines three technologies to reduce NO_x emissions for the combustion of natural gas. Combustion air/natural gas premixing, air staging and forced internal recirculation are integrated into a single burner to achieve low NO_x emissions without

sacrificing energy efficiency. The FIR burner provides increased radiant heat transfer from gas flames and more uniform flame temperatures for better furnace heat transfer.

Contact:

David Thornock
Johnston Boiler Company
(616) 842-5050
davidthornock@johnstonboiler.com



Benefits:

- ▶ Reduces NO_x emissions to less than 10 ppm and CO emissions to less than 25 ppm over the complete turndown range.
- ▶ Accommodates a wide range of combustion-chamber configurations

20 FIR burners have been installed on Firetube Boilers

M-PAKT™ Ultra-Low NO_x Burners: The World's Lowest Levels of NO_x and CO

Ultra-low NO_x emissions, high efficiency, and high heat transfer rates



These burners achieve ultra-low NO_x emissions by combining a unique type of clean-burning combustion technology called ultraclean, low-swirl combustion (UCLSC), with premixed flames. High energy efficiency is achieved in this type of combustion because the appropriate ratios of air and fuel are mixed to burn

completely. Also, the characteristically lifted flame of the burner provides for highly efficient energy conversion because no heat is lost in heat transfer from the flame to the burner.

Contact:

Maxon Corporation
(765) 284-3304
www.maxoncorp.com



Benefits:

- ▶ Generates 10 to 100 times less nitrogen oxide than conventional burners (less than 5 ppm)
- ▶ Costs comparable or lower than many conventional burners

MultiGas™ (Energy-Conserving Tool for Combustion-Dependent Industries): Combustion Tuning and Emissions Monitoring

On-line feedback resulting in lower energy use and emissions for boilers and turbines



The system allows for real-time measurement of criteria emissions and pollutants, including pollutants that are not usually monitored, such as formaldehyde and ammonia. The improvements in dependability and efficiency and the lack

of need for expansive temperature-controlled space result in lower operations, energy, and labor costs. The multi-gas analyzer technology is portable, low-cost, and energy efficient and combines advanced Fourier transform infrared spectroscopy with advanced electronics and software. This system provides continuous emissions monitoring (CEM) and online feedback for operational tuning of combustion-based industrial processes.

Contact:

MKS Instruments, Inc.
(800) 227-8766
www.mksinst.com



Benefits:

- ▶ Reduces maintenance and performance verification time, resulting in labor savings of up to 80%
- ▶ 10-100 ppb sensitivity for many toxic gases
- ▶ Simultaneous analysis and display of more than 30 gases

21 Units operating for boiler and turbine emissions monitoring in the U.S. through 2004

Enhancement of Aluminum Alloy Forgings

Advanced furnace uses radiant heating for high-performance forgings



The Advanced Heating System (AHS) uses an optimized combination of radiation and convection to heat aluminum billets faster than conventional gas-fired heating. This reduced heating time increases production rates, but also inhibits grain growth, and thereby doubles the fatigue life of the component. This process uses less energy than conventional batch-type gas-fired

heating. The system was developed at Oak Ridge National Lab in collaboration with Queen City Forging and other partners, and the equipment is manufactured by Infrared Heating Technologies.

Contact:

Charles Blue
Infrared Heating Technologies, LLC
(865) 574-9784
ctblue@infraredheating.com



**Infrared Heating
Technologies, LLC**

Benefits:

Compared to batch gas-fired heaters:

- ▶ Reduces energy consumption
- ▶ Increases production rate

**2004 R&D 100 Award
2005 Emerging Technology Award
from Ohio's Thomas Edison Program**

Intensive Quenching

A clean, efficient quenching technology for heat treating and forging



Intensive quenching (IQ) involves very rapid quenching of steel parts in violently agitated water. The high velocity of the water quenchant causes uniform development of surface stresses and a hard martensite layer, which together prevent cracking or

distortion of the part. The process is energy efficient and uses an environmentally friendly substitute, plain water, for conventional oil or water/polymer quenchants.

Contact:

Michael Aronov
IQ Technologies, Inc.
(216) 381-8159
(330) 773-4850
info@intensivequench.com

IQ Technologies Inc

Benefits:

- ▶ Reduces energy consumption
- ▶ Reduces production cost by up to 40%
- ▶ Improves strength of quenched part

2 units installed in the United States

MicroCure™ Variable Frequency Microwave Furnace

Consistent heating enhances materials development and processing



MicroCure™, a line of Variable Frequency Microwave furnaces, provides uniform energy distribution and reproducible heating with every run. By rapidly sweeping over a broad range of microwave energy, power distribution becomes uniform due to superposition of thousands of individual microwave modes. MicroCure™ furnaces are used in production for several different electronic manufacturing applications as well as development of new materials and processes, plasma processing, biomedical, diamond, semiconductor, and automotive processing.

Contact:

Bob Schauer
Lambda Technologies, Inc.
(888) 290-2873 ext. 258
bschauer@microcure.com

**Lambda
Technologies™**

Microwave solutions for the next generation in advanced materials processing

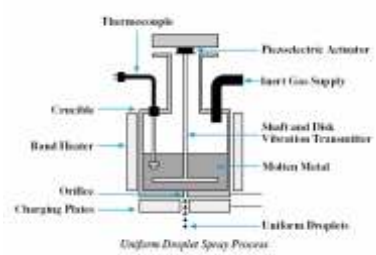
Benefits:

- ▶ Improves energy efficiency
- ▶ Reduces curing time by 95%
- ▶ Increases productivity
- ▶ Lowers processing temperatures

80 systems in operation, 47 in the United States

Uniform Droplet Spray (UDS) Process: Achieving Targeted Alloy Droplet Microstructures

Controlled droplet deposition for improved materials processing



The uniform droplet spray (UDS) process is a nongas atomization technique that produces uniform alloy droplets with identical thermal properties. UDS controls the breakup of a laminar jet, a method similar to ink-jet

printing, and deposits droplets according to the targeted microstructure. This process is ideal for producing novel particulate materials at high production rates, with low capital and operating costs.

Contact:
Jack Turner
Technology Licensing Office
Massachusetts Institute of Technology
(617) 253-6966
jht@mit.edu



- Benefits:
- Offers high quality alloy droplets
 - Saves time and energy over traditional methods

Licensed to 6 firms in the United States and Japan

H-Series Cast Austenitic Stainless Steels

Stronger, more reliable steels based on scientific design methodology



New H-Series cast austenitic stainless steels exhibit greater durability across a wide variety of operating conditions due to improved high strength compositions. The steels were designed using a combination of precise microstructure characterization and computational tools, providing them with more

strength at higher temperatures. These benefits apply to many applications, unlike other H-Series customizations that are effective only for specific conditions. Many applications can benefit from these new stainless steels, including the chemicals, forest products, heat treating, petrochemical, and steel industries.

Contact:
Tiffany Marcej
Duraloy Technologies, Inc.
(724) 887-5100
sales@duraloy.com



- Benefits:
- Reduces equipment downtime
 - Enables higher operating temperatures with fewer replacements
 - Improves energy efficiency and productivity

Ceramic and Refractory Low-permeability Components for Aluminum Melting and Casting

New cost-effective materials result in more energy efficient low-pressure die casting



A new class of materials for application on Dense Fused Silica (DFS) riser tubes exhibit excellent thermal shock properties and resistance to molten aluminum attack while remaining impermeable during low pressure aluminum die casting.

The tubes superior durability enables manufacturers to reduce equipment downtime, saving defect/rework costs. One zircon-based coating material system is now in commercial production.

Computer modeling of particle size distribution to minimize permeability has also led to the development of monolithic fused silica castables that are now in industrial tests.

Contact:
Pyrotek Inc.
(866) PYROTEK
(866) 797-6835



- Benefits:
- XL glaze coating extends tube life 3-5 times
 - Silica Castables extend tube life by 8 times in industrial trials
 - Use of improved riser tubes can save 206 billion Btu/year

More than 1,200 XL-coated DFS riser tubes sold

New Coating Improves Aluminum High Pressure Die Casting Process

Zirconia coatings greatly extend working life of aluminum die casting components



A durable zirconia coating enhances the wear properties and extends the lifetime of components used in high pressure die casting of aluminum parts. The coating's fine-grained structure protects tool inserts, core pins, and thermal sheaths from corrosion and erosion. This coating can also improve component lifetime and

performance in the metal-working, forging, internal combustion, turbine engine, and other high wear industries.

Contact:

Dwaine Stark
Chemical Composite Coatings Intl, LLC (C³)
(678) 624-0230
dwaine.stark@cccintl.com



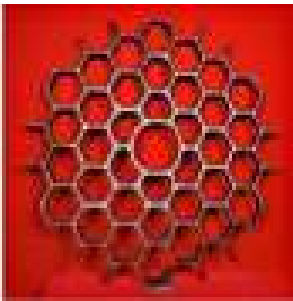
Benefits:

- ▶ Reduces component replacements and costs
- ▶ Improves quality of die cast parts and production yield
- ▶ Decreases equipment downtime and energy consumption

New coatings improve high pressure die casting component life up to 50 times

Nickel Aluminide (Ni₃Al) Intermetallic: Heat and Corrosion Resistant Alloys

High-strength intermetallic has many high temperature industrial applications



The nickel aluminide (Ni₃Al) intermetallic has a highly ordered crystal structure that provides high-temperature strength and oxidation resistance. The alloy's resistance to carburization and coking makes it ideal for use in steelmaking furnaces and is currently available as transfer rolls, forging dies, heat treating fixtures, and burner tubes. Ni₃Al

intermetallic allows higher operating temperatures, thereby reducing residence time, extending service-life, and improving energy efficiency.

Contact:

Roman Pankiw
Duraloy Technologies, Inc.
(724) 887-5100
techmgr@duraloy.com



Benefits:

- ▶ Improves productivity and product quality
- ▶ Increases creep and yield strength by 30-40%
- ▶ Up to 33% energy efficiency improvements

Over 500 fixtures are being installed

Improved Composite Tubes for Kraft Recovery Boilers

Study identifies materials and practices to enhance boiler efficiency and safety



The results of a multidisciplinary study identified both operational improvements and alloy materials to minimize recovery boiler composite tube cracking. The study found that a boiler tube cladding of modified alloy 825 was more resistant to floor tube cracking than alloy 625 or 304L stainless steel. The study's results are now being used worldwide for kraft recovery boiler installations and to design and fabricate new and rebuilt kraft

recovery boilers. Sandvik's Sanicro-38 co-extruded tubes, utilizing a modified alloy 825, have been in service for over 10 years with no reported recovery boiler floor cracking.

Contact:

Gary Boberick
Sandvik Materials Technology
(570) 585-7651
gary.boberick@sandvik.com



Benefits:

- ▶ Increases thermal efficiency
- ▶ Decreases boiler shutdowns
- ▶ Improves boiler safety

Over 80,000 meters of tubing sold

Parallel Beam X-Ray Diffraction System

Advanced X-ray optics enable on-line steel phase measurement



This x-ray diffraction (XRD) system is the first suitable for on-line measurement of steel composition. Measurements typically performed in the lab are now possible during production, because of the system's insensitivity to

sample position, temperature changes, and vibration. XRD technology can be used for measuring structural phases, stress, grain size, and crystal orientation. Compared to current XRD technology, X-Ray Optical Systems' product has increased x-ray intensity (up to 100 times), improved measurement efficiency, and decreased power consumption.

Contact:

Tom Bievenue
X-Ray Optical Systems, Inc.
(518) 880-1500 x702
tbievenu@xos.com



Benefits:

- ▶ Allows real-time, on-line monitoring
- ▶ Compact and portable
- ▶ Low power requirements

Fiber Optic Sensor for Combustion Measurement and Control

Robust system allows real-time monitoring of temperature and chemical composition



MetroLaser's system uses laser-based fiber optics to monitor the temperature and chemical composition of combustion gases. In contrast to conventional techniques such as extractive sampling, this system is non-intrusive and suitable for real-time process control. The fiber optic system is also insensitive to vibration, temperature, pressure,

flame luminosity, and particle interference, all of which can cause failure or calibration drift for conventional sensors.

Contact:

John Bergmans
Bergmans Mechatronics
(714) 474-8956
jbergmans@bergmans.com

Benefits:

- ▶ Non-intrusive measurements of gas temperature and H₂O concentration
- ▶ Improves measurement precision, resulting in energy savings

*Two systems in service for combustion monitoring
Three derivative systems operating in pharmaceutical applications*

Fiber Sizing Sensor and Controller: FibrSizr™

Revolutionary optical technology provides measurement of fiber sizes



The FibrSizr™ is a new technology that enables on-line measurements and process control for fiber size. The technology uses ensemble laser diffraction to provide accurate real-time measurements of fiber size distribution, reducing the time and labor needed for

off-line fiber size measurements. Fiber manufacturers for a broad range of polymers and glasses can utilize this technology to improve their operational performance.

Contact:

Amir Naqwi
Powerscope, Inc.
(612) 331-4247
anaqwi@powerscopetech.com

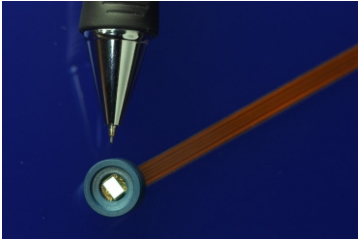


Benefits:

- ▶ Reduces energy and material waste
- ▶ Increased productivity and product quality

Solid-State Sensors for Monitoring Hydrogen

Innovation in hydrogen monitoring and control systems



These sensors provide real-time, point-of-use monitoring of hydrogen concentration for process control applications and leak detection. The solid-state technology does not require expensive support equipment, but produces

measurements comparable to systems about 30 times more expensive. H2scan's sensors show stable, repeatable operation over a wide range of hydrogen concentrations. They are suitable for many industrial applications, and are available as handheld units, area monitors, and in-line process monitors.

Contact:

Richard Saltzman
H2scan Corporation
(661) 775-9575
sales@h2scan.com



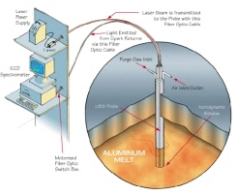
Benefits:

- ▶ Hydrogen-specific sensing
- ▶ Measurement range of 15 ppm to 100% vol H₂
- ▶ Compact and low power
- ▶ Unaffected by CO, sulfur gases, and moisture

Over 1,000 sensor systems sold

Laser-Induced Breakdown Spectroscopy (LIBS)

Improving product quality with in-situ, real-time measurement of melt constituents



The LIBS technology uses a laser and a spectrometer to measure the constituents of the melt in a process furnace. A laser is fired repetitively through a fiber-optic cable and into the melt through a probe. The laser vaporizes a small amount of melt at the probe tip to produce a plasma, which emits a signal that is detected and sent to a spectrometer. The LIBS system is in use for aluminum production, but has other applications in the steel and glass industries, such as monitoring trace alkali metal content in electronic glasses.



Contact:

Robert De Saro
Energy Research Company
(718) 608-8788
rdesaro@er-co.com



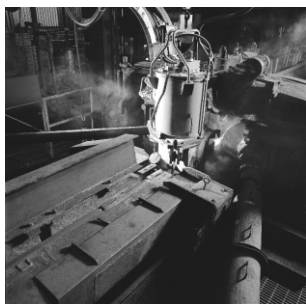
Benefits:

- ▶ Real time operation
- ▶ No calibration needed
- ▶ Eliminates furnace idle time for off-line measurements

Three units sold

On-Line Laser-Based Ultrasonic Thickness (LUT) Gauge

Effective, real-time measurements of steel tube wall thickness



The laser-based ultrasonic thickness (LUT) gauge is a non-contact, on-line system that measures steel tube wall thickness and eccentricity in real time. The system's real-time response allows managers to adjust the tubemaking process as variations are detected, rather than after an entire production run is completed. As a

result, tube manufacturers can produce more tubes meeting specifications and reduce the number reprocessed.

Contact:

Marc Choquet
Tecnar Automation
(450) 461-1221 ext. 227
mchoquet@tecna.com



Bob Kolarik
The Timken Company
(330) 471-2378
bob.kolarik@timken.com



Benefits:

- ▶ \$500,000 annual cost savings
- ▶ 5% energy savings
- ▶ Accuracy of +/- 0.5% in tube wall measurement

**1 million tubes inspected since 2002
2 units in operation; 4 more on order**

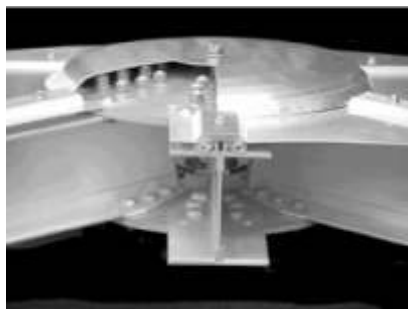
TECHNOLOGIES FOR TODAY

The following Knowledge-Based Results from technical research projects funded by DOE have contributed to the scientific understanding and improvement of industrial processes.

Aluminum

Calculation Methods for Extruded Aluminum Design

Methods improve design of aluminum shapes, save materials and energy



Integrated numerical methods were developed for accurately predicting the strength of extrudable aluminum structures. Researchers demonstrated a design methodology using finite strip analysis and studied the kinds of structures used in the

building, bridge, automotive, and other transportation industries. These methods will improve the design of irregular shapes and cold-rolled members.

Contact:

Teoman Pekoz
Cornell University
(607) 255-6366
TP26@cornell.edu

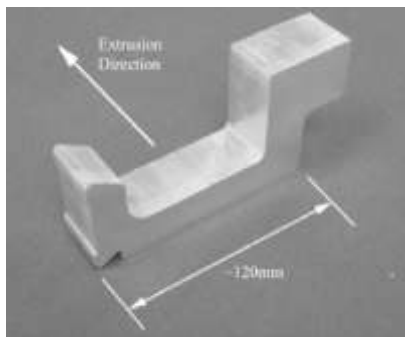


Benefits:

- Reduces energy use by 3.15 billion kWh
- Saves \$145.5 million/yr
- Reduces CO₂ emissions by 1.5 billion pounds/yr

Energy-Efficient Manufacturing of Superior Aluminum Extrusions

Improved extrusion processes save energy and materials, reduce emissions



An extrusion process and property prediction models for aluminum alloy extrusions were developed to increase metal yield and save energy. This 5% increase will save energy and materials and reduce CO₂ emissions. The methods developed in this study will improve the

consistency and efficiency of extrusion operations, benefitting producers and their consumers in the aerospace, transportation, and building industries.

Contact:

Richard W. Davies
Pacific Northwest National Laboratory
(509) 375-6474
rich.davies@pnl.gov

**Pacific Northwest
National Laboratory**
Operated by Battelle for the
U.S. Department of Energy

Benefits:

- Possible energy reduction of 600 billion Btu by 2010
- Saves 333 million pounds of billet material/yr
- Increases metal yield 5%
- Reduces CO₂ emissions

Design of Mold Surface Topography

Combined experimental and computational models improve ingot quality at reduced costs



Cornell University and Alcoa, Inc. developed computational and experimental models that improve mold surface topography designs and control shell surface and subsurface morphologies. This work integrates heat transfer and deformation analysis, melting, contact modeling, and metallurgical engineering.

Engineers using these models can design mold surface topographies that lead to desired

morphologies, reducing the amount of metal lost to furnace skimming operations and improving the quality of cast ingots.

Contact:

Nicholas Zabaraz
Cornell University
(607) 588-9104
zabaraz@cornell.edu

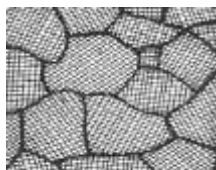


Benefits:

- Reduces scalping operation and costs
- Improves microstructures and ingot quality
- Optimizes shell surface morphology designs

Methods to Measure Aluminum Alloy Textures

On-Line Texture Monitoring for Controlled Recrystallization



New techniques were developed to improve strip-cast production of aluminum sheets by on-line monitoring to control the aluminum's recrystallization behavior and its related mechanical anisotropy and formability. This innovative technology may be applied across

all sheet production operations. Strip cast aluminum offers energy and materials savings as compared to conventional ingot casting and rolling.

Contact:

Zhong Li
Aleris International
(859) 514-4951
zhong.li@alcris.com



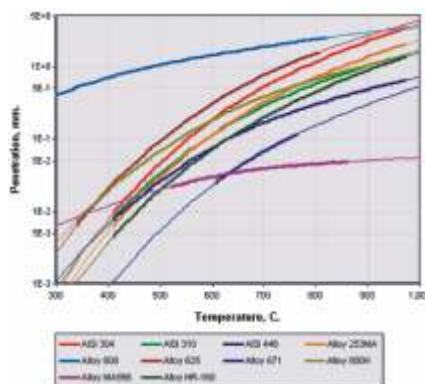
Benefits:

- Improves product recovery rate
- Increases productivity
- Reduces fuel consumption

Chemicals

ASSET: Alloy Selection System for Elevated Temperatures

Technology predicts industry mechanisms and rates in the chemical industry



ASSET software helps equipment designers and operators identify the right alloys for equipment used in environments with high temperature, corrosive gases. The software predicts corrosion mechanisms using thermochemical calculations and predicts corrosion rates using analyses of extensive

data bases, containing 12.9 million hours of corrosion data at 200 1200°C for 87 commercial alloys. These highly accurate predictions assist engineers in choosing the right alloys to increase process safety while avoiding expensive and overly conservative choices.

Contact:

Randy John
Shell Global Solutions (US) Inc.
(281) 544-7229
randy.john@shell.com



Benefits:

- Identifies cost-effective alloys
- Facilitates better equipment maintenance planning
- Reduces unplanned outages

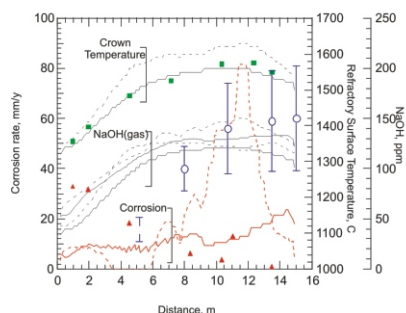
About 60 commercial licenses sold

Currently being extended to include more corrosion mechanisms and gasses

Glass

Modeling of Refractory Corrosion in Oxy-Fuel Glass Furnaces

Reduced corrosion lead to increased refractory life and furnace efficiency



The use of energy efficient oxy-fuel firing in glass melting furnaces requires refractories that are more resistant to corrosion than those used in traditional air-gas melting. Researchers gathered experimental data, determined corrosion factors, and developed mathematical models to

predict corrosion rates in several types of refractories. The results of the modeling work have been published in trade journals and incorporated in commercial furnace model codes, and thermodynamic data is available online. The results can be used to identify furnace conditions, furnace designs, and refractory compositions that lower corrosion rates.

Contact:

Mark Allendorf
Sandia National Laboratories
(925) 294-2895
mdallen@sandia.gov



Benefits:

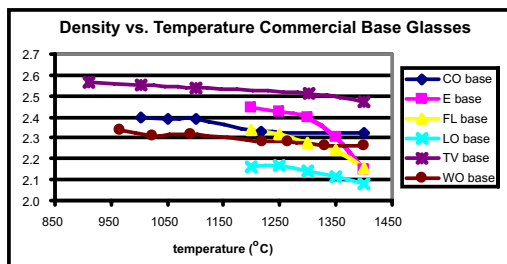
- Increased energy efficiency and productivity
- Improved refractory life and product quality

About 60 commercial licenses sold

Currently being extended to include more corrosion mechanisms and gasses

High-Temperature Glass Melt Property Database

Published database enables improved product and process modeling



The database, published in a 290 page book available for sale through the American Ceramic Society, contains information on many key glass melt

properties for several glass compositional families. This data can be used by the entire glass industry to improve modeling capabilities, which will ultimately improve glass melting and forming processes. Accurate, improved modeling can also eliminate the need for costly experimental melts to test for proposed process changes.

Contact:

Harrie J. Stevens
Center for Glass Research
Alfred University
607-871-2662
stevenshj@alfred.edu

CGR

Alfred University
Industry - University Center
For Glass Research
New York State College of Ceramics

Benefits:

- Improved efficiency
- Increased yields
- Reduced environmental impacts

Heat Treatment

Materials and Process Design for High Temperature Carburizing

A computational materials design approach for optimizing the carburizing process



An integrated approach to materials and process design enables high performance alloy producers to optimize the high temperature carburizing process and develop more durable case-hardened tool and die steels.

High temperature carburizing allows order-of-magnitude increases in case depth and 1000 VHN case hardness without the formation of detrimental primary carbides. The Center for Heat Treating Excellence has developed the methods for optimizing both vacuum and plasma high temperature carburizing processes for new high-temperature alloys.

Contact:

Diran Apelian
The Center for Heat Treating Excellence (CHTE)
Worcester Polytechnic Institute
(508) 831-5992
dapelian@wpi.edu



Benefits:

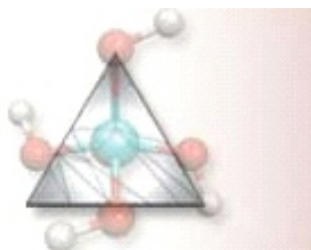
- ▶ Reduces carburizing energy consumption by a factor of 4
- ▶ Increases part durability to reduce scrap generation
- ▶ Eliminates need for chrome plating in many applications

Process used to produce over 20,000 lb/year of QuesTek Ferrium C61 and C69 tool steel

Materials

Thermomechanical Database for High Temperature Materials

Improving the availability and accuracy of thermochemical property data



A new database containing thermomechanical data for gas-phase and condensed-phase species improves simulations and modeling of materials and refractories in high-temperature industrial environments. The data include thermodynamic figures, models for non-ideal

behavior, and calculated molecular properties, so that both optimal selection of compatible materials, as well as interpretation of failure mechanisms can occur.

Contacts:

Available at <http://www.ca.sandia.gov/HiTempThermo/index.html>

Mark Allendorf
Sandia National Laboratories
(925) 294-2895
mdallen@sandia.gov



Theodore M. Besmann
Oak Ridge National Laboratory
(865) 574-6852
besmannm@ornl.gov

Benefits:

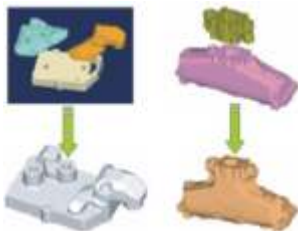
- ▶ Improves modeling capabilities
- ▶ Enables accurate thermodynamic predictions

**More than 70 subscribers
Over 15,000 hits since 2002**

Metal Casting

Lost Foam Casting Technology

Efficient production of high quality metal parts with improved



The Lost Foam Casting Process produces high value parts by eliminating cores and consolidating several cast components into one single casting. In addition, the technology improves casting dimensional accuracy to reduce materials consumption and

machining costs. All of these unique process features reduce energy consumption and have enabled lost foam casting production to grow in value. The University of Alabama at Birmingham and partners continue to build on the success of this commercial technology with further R&D improvements.

Contact:

Charles Bates
Casting Engineering Laboratory
University of Alabama
at Birmingham
(205) 975-8120
cbates@uab.edu



Benefits:

- Improves process control and quality of cast parts
- Increases energy efficiency
- Reduces scrap production from 25% to 3%

Lost Foam Casting production has grown in value from \$5 million/year in 1988 to \$800 million/year in 2002

Macro-Inclusions Atlas: Reducing Casting Rejections

Internet atlas compiles macro-inclusion causes and descriptions



The Macro-Inclusions Atlas provides foundry operators with access to information which they can apply on a real-time basis to reduce the frequency of macro-inclusions. Analysis and photos are available on a wide range of samples applicable to foundry operators. Through the analysis of the chemistry and size of problematic inclusions, foundry operators

can determine potential sources of macro-inclusions and identify countermeasures to reduce their occurrence.

Available at::

<http://neon.mems.cmu.edu/afs/atlas.html>

CARNEGIE MELLON UNIVERSITY

Benefits:

- Publically-available, easily accessible Internet tool
- Atlas of oxide macro-inclusions found in foundry-produced steel grades

Provides defect descriptions, mapping, and chemical composition for foundries

Steel

Deformation Behavior Model of Lightweight Steel Structures under Impact Loading

Tool could accelerate the implementation of safer lightweight steels in vehicles

The crash behavior of lightweight steel vehicles is simulated by an advanced computational model for assessing vehicle design and performance. This model builds

on the accomplishments of the Ultra Light Steel Auto Body-Advanced Vehicle Concept to provide insight into innovative, lightweight designs. Understanding lightweight steel performance will allow manufacturers to reduce vehicular weight while ensuring safety standards.

Contact:

Joe Vehec
American Iron and Steel Institute
(412) 922-2772 ext. 216
aisiap@aol.com



Benefits:

- ▶ Enables significant improvements in design of lightweight steel vehicle design
- ▶ Minimizes the number of physical structures needed to be built for testing
- ▶ Saves manufacturing time and money

Cold Work Embrittlement of Interstitial-Free Steels

Understanding CWE can reduce steel fractures during secondary formation

A standard, reliable methodology helps steel and parts manufacturers determine the effect of cold work embrittlement (CWE) on interstitial-free (IF) steel performance. The methodology evaluates the influence of steel chemistry and

processing conditions, microstructure, and test conditions on CWE. The study also provides CWE's effect on fatigue properties specifically in rolled and high strain, deep drawn conditions. This knowledge can help manufacturers take advantage of IF steel's advantages, such as low content of solute interstitial elements, while improving the reliability of steel parts.

Contact:

John Bowker
CANMET/MTL
(613) 992-0710
jbowker@nrcan.gc.ca



Joe Vehec
American Iron and Steel Institute
(412) 922-2772 ext. 216
aisip@aol.com



Benefits:

- ▶ Enables steel producers to increase supply of medium-strength IF steel
- ▶ Reduces fractures during secondary deformation
- ▶ Produces more reliable, lighter weight cars

Formability Characterization of Advanced High Strength Steels

Increased knowledge will result in lighter, safer, more energy efficient structures

Comprehensive research data characterize the formability of new high strength, lightweight steels, including dual phase and transformation-induced plasticity steels. Metallurgical strengthening mechanisms were quantified at

elevated strain rates, producing data on sheet steel capabilities under stress. This study also provides insight on the effects of strain on microstructures and property interrelationships. Understanding new steels and strengthening processes will enable the automotive industry to design safer lightweight systems, improving vehicle energy efficiency.

Contact:

Joe Vehec
American Iron and Steel Institute
(412) 922-2772 ext. 216
aisiap@aol.com



Benefits:

- ▶ Increases safety of high strength steel designs
- ▶ Improves use of input materials and resources

The following Emerging Technologies co-funded by DOE are expected to have commercial applications within the next three years. Fact sheets describing these innovations and other promising technologies are available at www.eere.energy.gov/industry.

Semisolid Forming of Aluminum Alloys



Semi-solid rheocasting is a cost-efficient and energy-efficient process for improving high-integrity, safety-critical aluminum die castings. By forming semi-solid slurries at the die casting machine, the process improves die casting quality and cost, particularly for automotive components. The process saves energy and reduces waste while boosting productivity. After licensing the technology from the Massachusetts Institute of Technology, IdraPrince, Inc. has successfully developed and sold machines that create the semi-solid slurries. One buyer has put the machines into production.

Contact: James Yurko from IdraPrince, Inc. at jayurko@idraprince.com

Vertical Flotation Melter



The vertical floatation melter (VFM) is an innovative melting process that decoats, preheats, and melts scrap aluminum in one operation. The VFM provides heat transfer coefficients 10 times higher than that of a conventional furnace, reduces emissions, and improves metal recovery. Energy Research Company operates a 1,000 pph pilot-scale VFM for experimental development in its Fayetteville, NY facility. Stein Atkinson Stordy Ltd. will commercialize the VFM in Europe.

Contact: Robert De Saro from Energy Research Company at rdesaro@earthlink.net

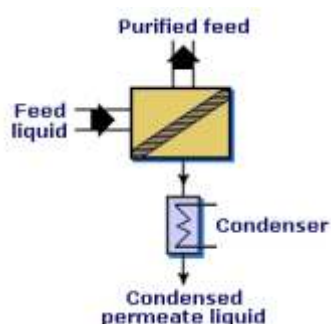
Electrodialysis Processing of Brine



A new electrodialysis technology recovers salt from aluminum salt cake for re-use by the aluminum industry by separating digested salt cake into aluminum, salt brine, and non-metallic products. This recovery technology is more cost-and energy-efficient than other methods of salt recovery. Argonne National Laboratory (ANL) developed this technology together with Alumitech, Inc., and is currently also pursuing commercial applications of the technology in the agricultural industry.

Contact: John Hryn from Argonne National Laboratory at hryn@anl.gov

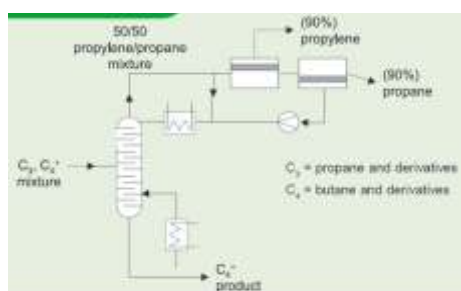
PerVap®: Membrane for Recovery of Organic Compounds



The PerVap® system uses a selectively-permeable membrane to separate volatile organic compounds (VOCs) from a liquid stream. The system is suitable for treating low-volume wastewater streams or for recovering a valuable organic compound, such as a food essence. Pervaporation can also be used to separate organic solutions, break azeotropes (closely boiling mixtures), and dehydrate solvents, which are difficult to do through distillation or other means. Membrane Technology and Research is field testing the system, and has demonstrated VOC recovery efficiencies of 99%.

Contact: Hans Wijmans from Membrane Technology and Research, Inc. at wijmans@mtrinc.com

Olefin Recovery from Chemical Industry Waste Streams



Ethylene and propylene (olefins) are the two highest volume organic chemicals produced in the United States. Approximately 1% to 2% of the olefin product is lost to an olefin/paraffin waste stream that is flared or used as fuel, resulting in a loss of approximately \$1 million per plant annually. Membrane Technology and Research is field testing a membrane technology that would enable olefin recovery from the waste stream, thus generating cost and energy savings.

Contact: Hans Wijmans from Membrane Technology and Research, Inc. at wijmans@mtrinc.com

Affinity Ceramic Membranes for Carbon Dioxide Separation



This ceramic membrane has an affinity for carbon dioxide and can be used to remove CO₂ from a variety of gas streams. Like other membranes, this system is more energy efficient and compact than conventional separation processes. It is also thermally, hydrothermally, and chemically stable, and so can be used in applications involving high temperatures and harsh environments, such as hydrogen production. Media and Process Technology developed the membrane and is currently pursuing commercialization.

Contact: Rich Ciora from Media and Process Technology, Inc. at rciora@mediaandprocess.com

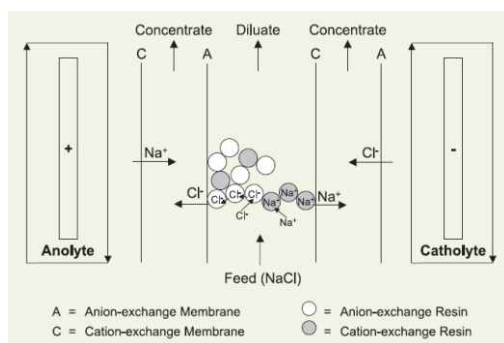
Alloys for Ethylene Production Furnaces



Ethylene production is one of the most energy intensive processes in the chemical industry, due to the decoking necessary to maintain ethylene furnace tubes. Oak Ridge National Laboratory and its industrial partners are developing and testing new intermetallic and metallic alloys that are resistant to coke build-up and carburization, along with the tube fabrication and welding methods necessary to implement the new alloys. The new materials will reduce the frequency of decoking and help save energy, boost productivity, and increase the structural life of the tubes.

Contact: Vinod Sikka from Oak Ridge National Laboratory at sikkav@ornl.gov

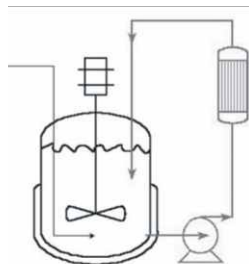
Electrodeionization for Product Purification



Advanced electrodeionization (EDI) combines features of ion exchange and membrane-based electrodialysis into an energy efficient process for removing dissolved salts. EDI has many potential uses including direct production and separation of products, product purification, desalination, salt waste recovery, and water recycling. Argonne National Laboratory and EDSep, Inc. received a 2002 R&D 100 Award for developing the technology, and have completed successful pilot tests. Based on the process economics of the pilot demonstrations, EDI is expected to reduce operating and capital costs by approximately 40%.

Contact: Seth Snyder from Argonne National Laboratory at seth@anl.gov

Catalytic Hydrogenation Retrofit Reactor



This new fixed-bed catalyst system replaces slurry catalysts used in batch hydrogenation processes. It can be retrofit into existing slurry tank systems, and eliminates the safety and environmental problems associated with handling powdered catalyst and with reprocessing or disposing of spent catalyst. The new reactor also improves yield, reduces operating costs, and reduces energy consumption. Air Products has tested the system at pilot plant scale and is making it available for license.

Contact: Gus Orphanides from Air Products and Chemicals, Inc. at orphangg@airproducts.com

High Octane Fuel via Catalytic Distillation



Exelus has developed a new process for producing a high-octane gasoline blend-stock (alkylate) to meet the rising demand for cleaner burning transportation fuels. Their unique solid-acid catalyst and novel fixed bed reactor allow the alkylation reaction to occur with higher energy efficiency than conventional liquid-acid processes. The ExSact process reduces both capital and operating expenses over conventional technology, and can be retrofit into existing refineries. Exelus has tested the process in a pilot plant and is beginning production-scale testing with two commercial refineries.

Contact: Mitrajit Mukherjee from Exelus, Inc. at mmukherjee@exelusinc.com

New Surfactants for Polyurethane Foam Production



The new silicone surfactant developed and commercialized by Air Products will allow polyurethane foam producers to improve production efficiency using carbon dioxide as a blowing agent instead of toxic methylene chloride. This new surfactant permits the production of a larger range of foam grades than was previously possible with first generation surfactants, thus increasing the manufacturer's competitive advantage vs. those in regions where methylene chloride use is still allowed. This technology combats global warming by reducing the net release of CO₂.

Contact: Mark Listemann from Air Products and Chemicals, Inc. at listemml@airproducts.com

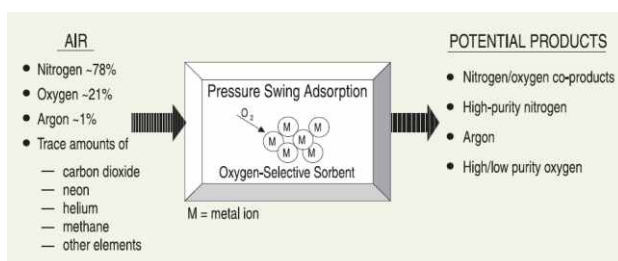
Membrane for Reducing Diesel Engine Emissions



Diesel engine exhaust is a major source of NO_x pollution. Compact Membrane Systems is developing a membrane that reduces NO_x emissions by enriching the nitrogen content of the engine intake air. The new membrane extracts oxygen from the intake air stream, altering its composition from 78% N_2 to 82% N_2 . Compact Membrane Systems is conducting laboratory and field tests with marine and locomotive companies, and has demonstrated reductions in NO_x emissions of up to 50%.

Contact: Stuart Nemser from Compact Membrane Systems, Inc. at snemser@compactmembrane.com

Sorbents for Efficient Gas Separation



Praxair has developed a process that combines a new oxygen-selective adsorbent material with pressure swing adsorption (PSA) to cost-effectively produce industrial gases, such as oxygen and nitrogen. This technology could also be used for purifying argon, helium, or other gases by removing trace quantities of oxygen while consuming less energy than conventional techniques. Praxair has tested the process and is evaluating options for further development and Commercialization.

Contact: Neil Stephenson from Praxair, Inc. at neil_stephenson@praxair.com

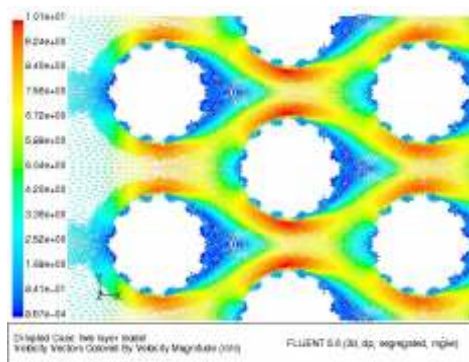
Membranes for Retaining Volatile Organic Compounds (VOCs)



An innovative membrane developed by Compact Membrane Systems retains volatile organic compounds while allowing air to permeate. This can be used to retain gasoline vapors that are vented from underground storage tanks, and thus reduce pollution and smog. The system is being tested for California Air Resources Board certification, and has the potential of saving 180 million gallons of gasoline annually when commercialized.

Contact: Stuart Nemser from Compact Membrane Systems, Inc. at snemser@compactmembrane.com

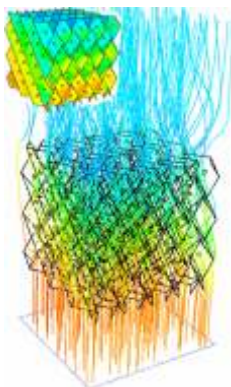
Dimpled Tube Heat Exchangers for the Chemical Industry



Cost-effective dimpled tube technology improves the thermal efficiency of convective sections of industrial fired process heaters by up to 15-20% while having a strong potential for mitigating fouling rates. Each dimple on the tube surface generates a vortex in the gas flowing over it, thereby intensifying convective heat transfer. Unlike other approaches to increase heat transfer rates in the convective section of process heaters, dimpled tube technology does not increase the pressure drop across the tube bank. The Gas Technology Institute has completed pilot-scale trials and is preparing for a full-scale demonstration.

Contact: Yaroslav Chudnovsky from the Gas Technology Institute at yaroslav.chudnovsky@gastechnology.org

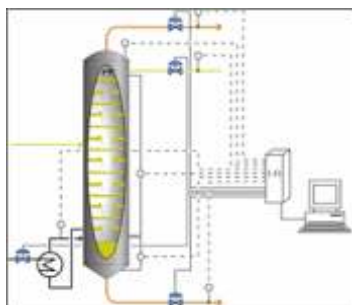
Distillation Column Modeling Tools



The Graphical Structured Packing Interface (GraSPI) is a software package for creating high-fidelity geometries for fluid flow simulation through packing elements used in distillation columns. The software was built as a derivative of FLUENT software, and the combined GraSPI and FLUENT software will allow plants to improve column design and operating parameters to increase product purity and reduce energy use. Oak Ridge National Laboratory (ORNL) developed this software in collaboration with University of Texas at Austin and Fluent, Inc.

Contact: Valmor de Almeida from Oak Ridge National Laboratory at dealmeidav@ornl.gov
Bruce Eldridge from University of Texas at Austin at rbeldr@che.utexas.edu

Distillation Column Flooding Predictor



The flooding predictor uses a patented pattern recognition system to identify the onset of flood and pre-flood conditions in distillation and separation columns. Distillation is a low-efficiency operation that consumes about 4.8 quadrillion Btu each year. The ability to predict and avoid flood conditions allows refiners to operate columns nearer their true hydraulic limit, increasing throughput and energy efficiency. 2ndpoint LLC is testing the system on a commercial scale and preparing for commercialization.

Contact: George Dzyacky from 2ndpoint, LLC at ged@2ndpoint.com

Gas-Fired Paper Dryer



An innovative, natural gas-fired drum dryer incorporates a ribbon burner and dimpled heat transfer surface to increase the rate and energy efficiency of paper drying. The Gas Technology Institute, together with Boise Paper Solutions, the Flynn Burner Corporation, the Groupe Laperrière and Verreault USA have developed and demonstrated this gas-fired approach on Western Michigan University's pilot paper machine. The project team is currently developing a full-scale unit for technology demonstration and showcasing benefits for paper producers in the State of Minnesota.

Contact: Yaroslav Chudnovsky from the Gas Technology Institute at yaroslav.chudnovsky@gastechnology.org

Laser-Ultrasonic Web Stiffness Sensor



A non-contact sensor for measuring paper stiffness guides real-time process control to optimize paper quality and reduce waste reprocessing costs during manufacture. The Lawrence Berkeley National Laboratory and the Institute of Paper Science and Technology at Georgia Tech developed and demonstrated the technology at MeadWestvaco and Boise Mills.

Contact: Rick Russo from the Lawrence Berkeley National Laboratory at rerusso@lbl.gov

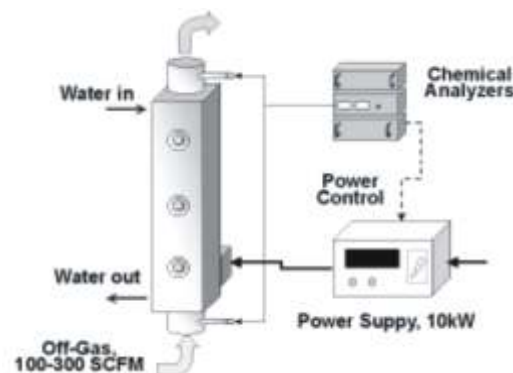
Electrohydraulic Contaminant Removal



An innovative technology uses an underwater spark to "detackify" stickies and pitch in the processing streams at secondary fiber mills. The spark technology reduces electricity and chemical use while improving fiber quality. The Institute of Paper Science and Technology (IPST) has conducted several mill trials to evaluate and validate this technology. The technology has been licensed to Eka Chemicals.

Contact: Sujit Banerjee from IPST at sujit.banerjee@IPST.edu

Low Temperature Plasma Technology for Controlling VOC Emissions



A new technology uses non thermal plasmas that can selectively destroy volatile organic compounds (VOCs) by producing excited ions or free radicals that oxidize, reduce, or decompose pollutant molecules. This easy-to-install technology can cost effectively reduce VOC emissions in pulp mills and wood products plants. Drexel University and the Pacific Northwest National Laboratory developed this system, which has been demonstrated at a Georgia-Pacific Corporation mill. Drexel is currently working with Matpro on further tests and commercialization efforts.

Contact: Alexander Fridman of Drexel University at fridman@drexel.edu

Steam Cycle Washer



A new, high-consistency pulp washer will allow pulp mills to decrease the water content of their weak black liquor stream, cutting the evaporator load by half. Pilot plant evaluations confirm the feasibility of high-consistency pulp washing using a pressure vessel charged with steam. Port Townsend Paper Corporation is now working with 21st Century Pulp & Paper, LLC and the Idaho National Laboratory to prepare for the fabrication and mill installation of a commercial-scale Steam Cycle Washer at the Port Townsend paper mill in Washington.

Contact: Andy Karlsnes from the Port Townsend Paper Corporation at andyk@ptpc.com

Directed Green Liquor Utilization (D-GLU) Pulping



To reduce the lime kiln load and digester energy intensity, a novel process redirects 20-30% of the green liquor from the causticizing plant to the digester. North Carolina State University and the Georgia Institute of Technology are currently performing a series of laboratory pulping experiments along with mill pulp and black liquor analyses. A full-scale mill trial incorporating these results is planned for 2006 at Evergreen Pulp in Samoa, CA.

Contact: Lucian A. Lucia from North Carolina State University at lucian.lucia@ncsu.edu

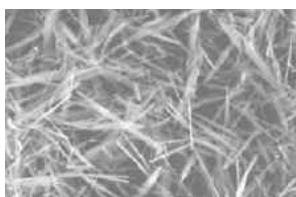
Oxalic Acid Pretreatment



Pretreatment of wood chips with dilute oxalic acid solution for about 10 minutes reduces electrical energy requirements for mechanical pulping by 25%, improves paper strength properties, reduces pitch content, improves dewatering, and produces value-added chemicals enabling a biorefinery dimension. Biopulping International, Inc. developed the technology together with several industrial and university partners, and has completed a successful pilot scale demonstration at Andritz's pilot plant. The economics look very promising, with a payback of 2 years or less.

Contact: Masood Akhtar from Biopulping International., Inc at makhtar@cttinc.org

Fibrous Paper Fillers



Novel calcium and silica-based fillers can displace over 40% of the pulp in papermaking while maintaining critical paper properties and reducing energy use. G.R. International (GRI) has been working with Western Michigan University to optimize laboratory and pilot-scale production of the fibrous fillers and evaluate their performance. GRI is also working with various industrial partners, including Grays Harbor Paper Company, Weyerhaeuser Company, and Ferenco, to evaluate the technical and economic performance of the technology in papermaking.

Contact: Vijay Mathur from GRI at mathur108@aol.com

Biological Air Emissions Control



A novel, sustainable sequential biological treatment system integrates two types of bio-oxidation systems, biotrickling filtration and biofiltration, for cost-effective air emissions control. Developed by Bio-Reaction Industries and Texas A&M University-Kingsville, this system uses microorganisms to degrade air toxins without using natural gas as fuel or creating secondary pollutants. This technology is now being implemented and optimized at a Stimson Lumber Company facility. With assistance from development partners, Bio-Reaction Industries is working to commercialize this technology for the wood products panel board market and pulp mills.

Contact: Kim D. Jones from Texas A&M University-Kingsville at kjones@tamuk.edu

Multiport Dryer Technology



A new multiport dryer design increases paper drying rates using smaller-sized ports (or longitudinally-oriented flow passages) located near the inside surface of the cylinder dryer. This revolutionary design substantially improves heat transfer by minimizing the condensate layer thickness and increasing the drying shell's surface temperature. Argonne National Laboratory and the University of Illinois at Chicago developed this technology in collaboration with industrial partners. Project industrial partners, Kadant Johnson and International Paper, will commercialize this technology after successful full-scale demonstration and field tests are completed.

Contact: Rick Russo from the Lawrence Berkeley National Laboratory at rerusso@lbl.gov

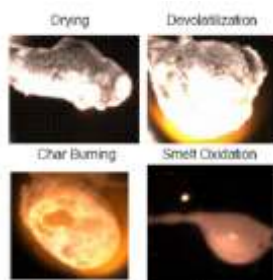
The Lateral Corrugator



A lateral corrugator technology increases box strength and reduces drying costs. The new method aligns corrugations with the paper machine direction, rather than being arranged perpendicularly. This technology enables manufacturers to use thinner paper to produce boxes of equal strength while reducing drying energy requirements. Additionally, this technology will result in significant cost and energy savings through waste reduction, trim optimization, reduced box plant inventory, and transportation optimization. The Institute of Paper Science and Technology at Georgia Tech along with thirteen project partners developed this technology and are planning Initial commercial implementation at a facility that produces boxes in bulk.

Contact: Michael Schaepe from the Institute of Paper Technology at Georgia Tech at michael.schaepe@ipst.gatech.edu

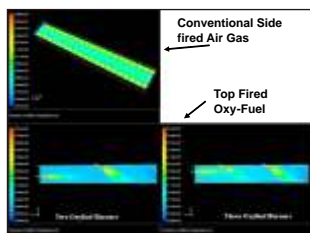
Recovery Boiler Modeling



A highly validated software model describes black liquor and biomass combustion for particles of arbitrary shape and size and a series of novel experimental techniques provide nonintrusive. Boiler operators using this diagnostic tool can monitor combustion characteristics that were previously difficult to monitor. Improved modeling capability will improve boiler operation control, productivity, and energy efficiency. Brigham Young University and several collaborators developed these models and are pursuing patents. Upon release, the software will be available for public use.

Contact: Larry Baxter from Brigham Young University at larry_baxter@byu.edu

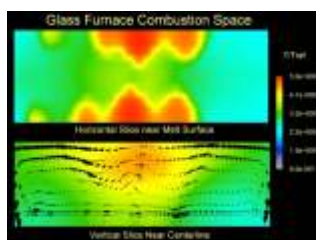
Advanced Oxy-Fuel-Fired Front-End System



Oxy-fuel-fired front-end technology provides significant improvements in energy consumption and decreased CO₂ emissions by replacing air-gas burner systems and optimizing heat transfer distribution. Owens Corning has developed this technology in collaboration with Eclipse Combustion and BOC Gases. Full-scale testing of the front-end system is underway in one of Owens Corning's fiberglass plants.

Contact: Steve Mighton from Owens Corning at Steve.Mighton@owenscorning.com

Coupled Combustion Space Modeling



A three-dimensional combustion space/melt tank/batch melting model using real-world furnace data and conditions has been developed in order to better regulate heat flux distribution on the batch and glass melt surfaces both in existing and new glass furnaces. Argonne National Lab has led an industrial consortium, including several glass manufacturers, in the development of this model. Industrial consortium members are evaluating and validating the model for potential application.

Contact: Steve Lottes from Argonne National Lab at slottes@anl.gov

High Intensity Plasma Melting



An innovative, modular glass melter utilizes electric-based plasma melting and increases torch life and process stability. Plasmelt Glass Technologies, LLC is developing this technology; AGY and Johns Manville also contribute. Plasmelt is conducting exploratory glass melting trials on a wide variety of glass compositions and is continuing to improve process parameters in its pilot-scale melter.

Contact: Ron Gonterman from Plasmelt at Ron@plasmelt.com

Improving Yield in Fiber Drawing



Through modeling and improved process control techniques for glass fiber drawing, reductions in break frequency for fiber drawing can be reduced by a factor of four. Cleveland State University, in conjunction with PPG Industries and Johns Manville, has led an industrial consortium in developing these improvements. The pilot-scale drawing tower has successfully demonstrated only one break in a four-hour period; technology transfer to the plant floor is being pursued.

Contact: Simon Rekhson from Cleveland State University at s.rekhson@csuohio.edu

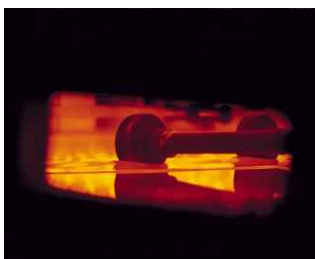
Measurement and Control of Glass Feedstocks



A laser-induced breakdown spectroscopy (LIBS) instrument measures the chemical make-up of glass batch materials in order to detect contaminants and batch nonuniformity. Energy Research Company developed the technology and the associated analyzer. A long-term plant demonstration of the commercial instrument is ongoing at a PPG Industries facility.

Contact: Arel Weisberg from Energy Research Company at aweisberg@er-co.com

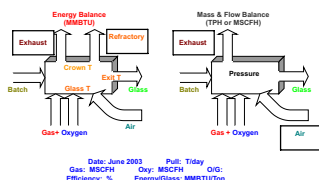
Model of On-Line Coating of Float Glass



A computational model of tin oxide deposition by chemical vapor deposition predicts growth rates on a float-glass line as a function of process parameters. Sandia National Laboratories (Sandia) and PPG Industries developed this model and tested it using data from laboratory experiments and measurements in a pilot-scale coating reactor at PPG's Glass Technology Center. The model, together with kinetic data describing the decomposition of the tin precursor and thermodynamic information for gas-phase species present during growth, can be obtained from Sandia.

Contact: Mark Allendorf from Sandia National Lab at mdallen@sandia.gov

Oxy-Fuel Protocol



By better monitoring and characterizing oxy-fuel furnace operations through advanced measurement techniques and mass and energy balances, operational inefficiencies can be identified and energy saving changes can be recommended. This best practice was developed by the Institute for Clean Energy Technology at Mississippi State University in cooperation with Eclipse Combustion and PPG Industries. PPG evaluated the protocol at one of their facilities and is exploring opportunities for additional technology transfer.

Contact: Brian Kauffman from Mississippi State University at kauffman@icet.msstate.edu

Submerged Combustion Melting



In submerged combustion melting (SCM), flames are fired directly into a bath of molten glass, leading to intense melting and mixing that can significantly reduce size and capital costs. This process provides excellent homogenization, while combustion within the melt enables high thermal efficiency and lower gas-phase emissions. The Gas Technology Institute (GTI) is leading an industrial consortium of five glass companies (Corning, Johns Manville, Owens Corning, PPG, and Schott North America) in development, demonstration, and detailed modeling of this technology. The team has demonstrated melting of a range of glasses in a lab-scale melter and is constructing a pilot-scale SCM to continuously melt up to 1 ton/h of glass.

Contact: David Rue from the Gas Technology Institute at david.rue@gastechnology.org

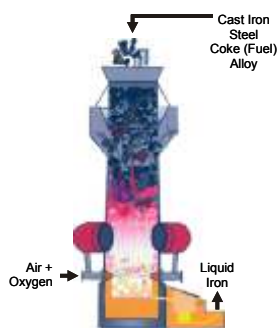
Monitoring and Control of Batch Carryover and Alkali Volatilization



A high-temperature laser-induced breakdown spectroscopy (LIBS) sampling probe measures the time-dependent batch carryover and alkali concentrations in the exhaust of glass furnaces. Volatilized alkali metals contribute to refractory crown corrosion and both carryover and volatilized alkali increase particulate emissions. Sandia National Laboratories developed and tested the LIBS probe, in collaboration with the University of Alabama-Birmingham, and the Gallo Glass Company. A conceptual design has been developed for a low-cost, low-maintenance LIBS probe sampling system.

Contact: Chris Shaddix from Sandia National Labs at crshadd@sandia.gov

Cupola Furnace Process Model



A new computer model improves process control by integrating many operational variables of cupola furnaces. This comprehensive model develops heat and material balances to further optimize furnace operations and reduce energy consumption and greenhouse-gas emissions. S. Katz & Associates, in collaboration with the American Foundry Society, GM-Research, and more than 20 industry sponsors developed this technology and is looking to form a strategic partnership for commercialization.

Contact: Seymour Katz from S. Katz & Associates at skatzassociates@gmail.com

Heat Treatment Model for Aluminum Castings



An integrated heat treatment model would allow manufacturers to optimize their thermal cycle and achieve specified microstructures and mechanical properties in critical sections of aluminum alloy castings. It would also allow the development of improved alloys and more efficient thermal cycles. This project involves developing and verifying such a model and integrating it with commercial casting process simulation and design software. The University of Connecticut, the University of Massachusetts-Amherst, and the Worcester Polytechnic Institute are developing the heat treatment model together with several industrial partners.

Contact: Yiming Rong from Worcester Polytechnic Institute at rong@wpi.edu

Through-the-Earth Communications for the Mining Industry



A wireless radio system, with a range of over 100 meters through the earth, increases underground mining safety and productivity by enhancing communications and position information. Los Alamos National Laboratory and several partners originally developed this technology. Vital Alert is retrofitting this technology to existing products and also applying for Mine Safety and Health Administration approval.

Contact: Joe Miller from Vital Alert at jmiller@vitalalert.com

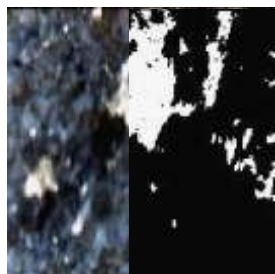
Mapping with Natural Induced Polarization



A new field polarization survey uses natural electromagnetic fields to collect induced polarization (IP) data and eliminates the need for conventional gasoline-powered equipment. This portable, noninvasive device provides better depth of exploration and reduces energy and drilling Requirements. Electromagnetic Instruments, Inc., now known as EMI Technology Center with Schlumberger, developed and demonstrated this technology, along with Placer Dome Exploration Inc., Kennecott Exploration Company, and Quantech Consultants.

Contact: Edward Nichols from Electromagnetic Instruments, Inc.
at enichols1@richmond.oilfield.slb.com

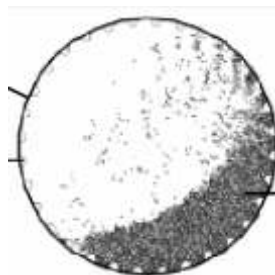
Real-Time Coal/Ore Grade Sensor



An innovative real-time sensor utilizing hyperspectral imaging is being developed to quantify ore grade during exploration, mining, and processing operations. This sensor will soon be tested in the Stillwater Pt/Pd mine in Montana. Partners for this effort include Big Sky Geophysics, Montana Tech, and Stillwater Mining Company.

Contact: Rand Swanson from Resonon, Inc. at swanson@resonon.com

Grinding Mill Optimization Software



New 3-D simulation software visualizes charge motion and provides quantitative information (power, forces on mill lifters, wear, etc.) for semi-autogenous grinding (SAG) mills and ball mills. The software models individual collisions of ball and rock particles, allowing improved lifter design and operating conditions. The University of Utah developed this technology in partnership with Idaho National Engineering Laboratory, Process Engineering Resources Inc., and Kennecott Utah Copper Corporation. The software has been successfully demonstrated for plant scale semi autogenous mills and is being updated for computational speed and visualization speed.

Contact: Raj Rajamani from the University of Utah at rajamani@mines.utah.edu

GranuFlow™ Process for Coal Preparation



The GranuFlow™ treatment process agglomerates fine coal particles for easy capture from the slurry of coal and water prior to mechanical dewatering. This technology reduces moisture content and mitigates problems with downstream handling, dusting, and freezing. Commercial-scale testing found that GranuFlow is capable of recovering an additional 100,000 tons/year of high-quality coal that would normally be disposed in a waste impoundment. This process was developed by DOE's in-house research group at NETL's Pittsburgh facility and CQ Inc. Several project partners are completing commercial testing.

Contact: David Akers from CQ Inc. at dakers@cq-inc.com

Drill-String Radar Navigation for Horizontal Directional Drilling



An innovative drill-string radar (DSR) technology identifies coal-rock boundaries to guide horizontal drilling in coal seams. In contrast to conventional gamma sensors, this radio-wave-based sensor withstands drilling vibrations and can be used for real-time control. DSR thereby reduces the energy, risk, cost, and time required for horizontal drilling. Stolar Research Corporation worked with industrial partners to develop the DSR technology, a 2005 R&D 100 Award winner, and is planning near-term commercialization efforts.

Contact: Jerry Stolarczyk from Stolar Research Corporation at gls@stolarhorizon.com

Dense-Medium Cyclone Optimization Tools



New engineering tools provide real-time feedback to improve the energy efficiency of dense-medium cyclone operations. These user-friendly tools allow operators to assess, troubleshoot, and predict cyclone performance. Virginia Polytechnic Institute, together with Massey Coal Services, Precision Testing Laboratory, and Partition Enterprises, developed and conducted field tests of these software tools. The project team is working on a marketing agreement to distribute the software via the web.

Contact: Gerald Luttrell from Virginia Tech at luttrell@vt.edu

Life Improvement of Pot Hardware in Continuous Hot Dipping Processes



A new generation of pot hardware materials resistant to corrosion and dross buildup in the liquid zinc bath, improves efficiency of continuous hot dip processes, and reduces production shutdowns. A research team from West Virginia University, Oak Ridge National Laboratory, International Lead Zinc Research Organization, and eighteen private sector costs partners developed new materials and processed currently available materials in novel ways to yield protective properties for hot dip pot hardware. Production line trials of the new materials, demonstrating extended hardware lifetime, are being conducted at several steel plants with galvanizing lines.

Contact: Carl Irwin from West Virginia University at carl.irwin@mail.wvu.edu

Mag-Gate™ System for Molten Metal Flow Control



The Mag-Gate™ is an electromagnetic system for active molten metal flow control. This system improves continuous steel making by reducing pouring turbulence, re-oxidation, and impurity entrapment. Precise flow control of steel from the tundish to the mold is critical for quality control improvement, increasing yields, and saving energy. The Mag-Gate™ system has the potential to increase sequence length leading directly to strand yield improvement, energy savings, and operating cost reductions. Concept Engineering Group, Inc. developed this technology with the American Iron and Steel Institute's Technology Research Program (AISI/TRP) and is working toward commercialization.

Contact: Richard Nathenson from Concept Engineering Group, Inc. (CEG) at richnathenson@air-spade.com

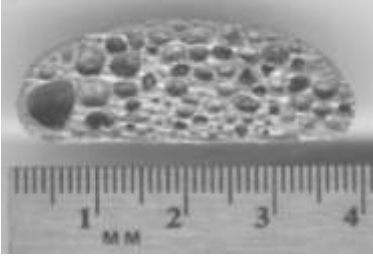
Oscillating Combustion Valve Technology



An innovative oscillating valve added to a burner's gas line reduces NO_x emissions and improves furnace productivity by forcing fuel rate oscillation. This retrofit valve controls fuel flow rate to the furnace, creating successive fuel-rich and fuel-lean zones. The Gas Technology Institute (GTI) developed this technology, which was successfully demonstrated at a Nucor Steel facility, with Questar Gas co-funding. Air Liquide and Precision Q Systems are also licensed for specific applications of the oscillating combustion technology. This technology requires the use of a proprietary oscillating valve that GTI has sublicensed to WBM, Inc. for manufacturing.

Contact: Harry Kurek from the Gas Technology Institute at harry.kurek@gastechnology.org

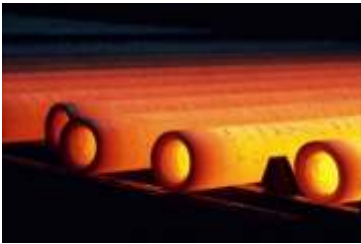
Steel Foam Materials and Structures



New metal foams with efficient energy absorption characteristics are approximately 50% lighter than conventional steel materials, thereby improving fuel efficiency and passenger safety when used in transportation systems. These foams are produced through a powder metallurgy process that may utilize recycled scrap. The Fraunhofer USA Center in Delaware has enhanced the metallic foam production process originally developed by Fraunhofer in Germany. Alulight of America is now working with Lightweight Solutions to commercialize the technology.

Contact: Francis Roland-Lee from Fraunhofer USA at froland@fraunhofer.org

Controlled Thermo-Mechanical Processing: Tube Optimization Model (TOM)



DOE's Controlled Thermo-Mechanical Project (CTMP) developed the tube optimization model (TOM), which formulates hot deformation recipes that yield a targeted steel tube microstructure right off the mill. This model eliminates the need for post-processing heat treatments by calculating the best time and temperature combination from thermal, mechanical, and metallurgical data. Its user interface has data input capabilities that ensure that the model remains up-to-date with new process breakthroughs. The Timken Company developed this technology in collaboration with several research partners and is currently working toward a commercialization agreement.

Contact: Robert Kolarik from The Timken Company at bob.kolarik@timken.com

Process Heater System



The advanced process heater system combines three technologies to achieve ultra-high efficiency and extremely low emissions: an ultra-low emission (ULE) burner, an enhanced fired heater with high heat recovery capability, and on-line temperature sensors with a burner control system. Designed for new and retrofit applications, the process heater system will be applicable for petroleum refining and chemical processes. The burner system is commercially available, and the advanced heater design is currently undergoing commercialization.

Contact: Howard Mason from TIAX LLC at mason.howard@tiax.biz

Super Boiler



The Super Boiler design allows for ultra-low emissions, reduced footprint, and reduced weight. This is achieved through an integrated package design which combines the advantages of a staged, intercooled combustion system with forced internal recirculation, high-intensity heat transfer surfaces, an advanced transport membrane condenser, and a smart control system. The performance goals for the technology include 94% fuel efficiency, 5 ppmv NO_x and CO emissions, and 50% size and weight reduction compared with conventional boilers. The first generation Super Boiler has been developed and field tested. Three new agreements have been made for the development of second generation Super Boilers.

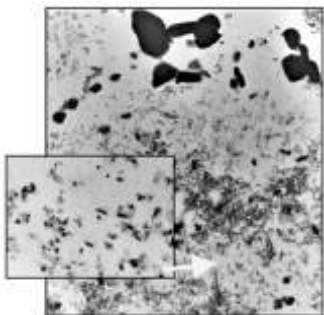
Contact: Rick Knight from the Gas Technology Institute at rick.knight@gastechnology.org

Iron Chromium Alloys

A novel iron chromium alloy resists aqueous corrosion and contains silicon for high temperature oxidation resistance. The alloy can be cast, hot-formed, and welded in thin sections without pre- and post-weld heat treatments. Oak Ridge National Laboratory developed this alloy, which has significant potential for the glass and chemicals industries.

Contact: Vinod Sikka from Oak Ridge National Laboratory at sikkav@ornl.gov

Chromium Tungsten Alloys for Reaction Vessels



Chromium tungsten alloys are a unique class of steels that maintain strength, toughness, and stability during thermal cycling. These alloys enable energy savings in reaction vessels and heat transfer tubing by reducing required wall thickness and improving heat transfer. Oak Ridge National Laboratory developed the alloys and has submitted them for ASME approval before commercialization.

Contact: Vinod Sikka from Oak Ridge National Laboratory at sikkav@ornl.gov

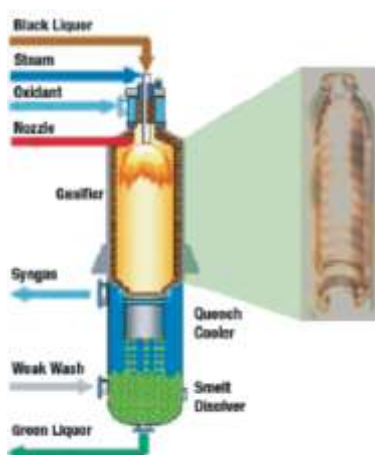
Advanced Weld Overlays



A new weld overlay process is used to enrich the surface aluminum concentration of carbon steel or nickel-based alloy substrates. Welding with pure aluminum wire creates an overlay that contains 8-10% aluminum for improved oxidation, carburization, and sulfidation resistance. Oak Ridge National Laboratory developed the weld overlay alloy and is working with industrial partners for commercial testing.

Contact: Vinod Sikka from Oak Ridge National Laboratory at sikkav@ornl.gov

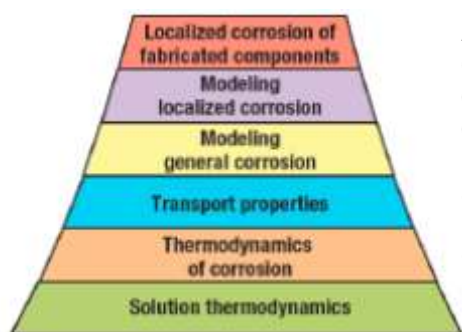
Materials for High-Temperature Black Liquor Gasification



Degradation-resistant materials for black liquor gasifiers help prevent costly material loss due to high alkali concentrations and temperatures. Oak Ridge National Laboratory, University of Missouri-Rolla, Weyerhaeuser, and several other partners developed these materials for gasifier refractory linings and nozzles. Compared to the typical six-month lifetime, these new materials continue to show excellent resistance to corrosion and spallation after more than one year of operation at a Weyerhaeuser mill.

Contact: James Keiser from Oak Ridge National Laboratory at keiserjr@ornl.gov

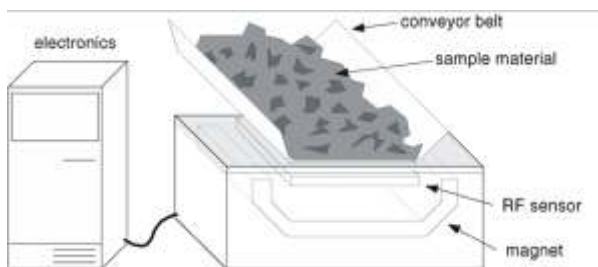
Predicting Corrosion of Advanced Materials and Fabricated Components



An innovative modeling tool and commercial software package predicts the occurrence of localized corrosion and pitting damage accumulation for many alloys used in corrosive environments. This technology gives users a better understanding of local corrosion behavior and enables them to select better alloys for components. OLI Systems, Inc. developed this technology in conjunction with several industrial partners and is currently working on commercialization plans.

Contact: Andre M. Anderko from OLI Systems, Inc. at aanderko@olisystems.com

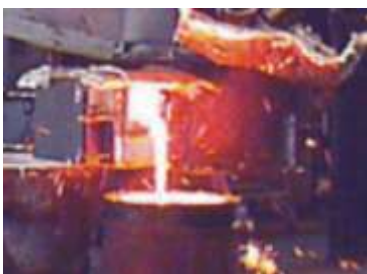
Magnetic Resonance On-Line Sensor



This sensor uses magnetic resonance to measure properties, such as moisture content. Energy savings are possible by monitoring the moisture content of wood chips entering the papermaking process, by preventing excessive drying of grains, or by monitoring coal composition in power plants. The system has been tested by GE Security and project partners.

Contact: Erik Magnuson from GE Security at erik.magnuson@ge.com

Sensing and Control of Cupola Furnaces



Cupola furnaces account for 70% of cast iron production and generate significant greenhouse gas emissions. This integrated sensing and control system can regulate the furnace melt rate, temperature, and metal composition. Successful control increases energy efficiency, increases iron quality, and decreases environmental impact. The system has been developed by the Tennessee Technological University, the Albany Research Center, and industrial partners.

Contact: Mohammed Abdelrahman from Tennessee Technological University at mabdelrahman@ntech.edu

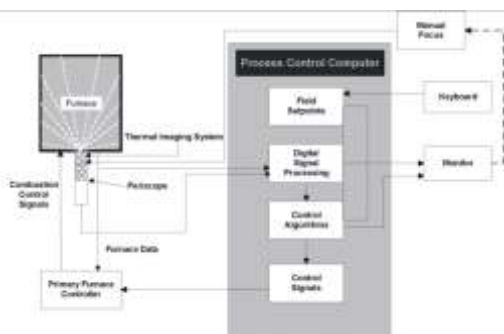
SQA™: Surface Quality Assured Program for Hot Rolled Steel Bars



The problem of surface defects in hot rolled steel bars is one of the most common quality issues faced by the American steel industry, accounting for roughly 50% of all steel bar rejects. The Surface Quality Assured (SQA™) system detects these defects in real-time to mark them for downstream removal. OG Technologies has already commercialized a first-generation HotEye™ imaging sensor to identify defects and is developing major enhancements to increase system accuracy and identify the root cause of defects.

Contact: Terence Liddy from OG Technologies at Liddy@ogtechnologies.com

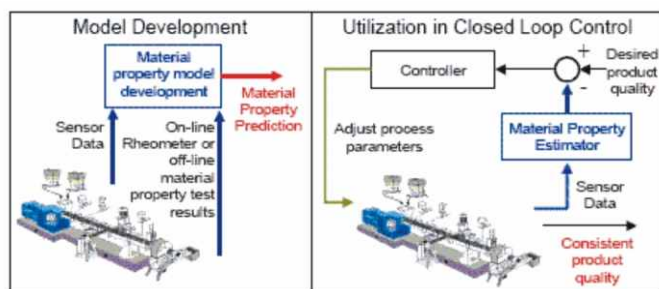
Thermal Imaging of High-Temperature Furnaces



This near-infrared thermal imaging system integrates with existing furnace controllers to fine-tune the combustion process. A periscope probe is used to map the combustion space and eliminate hot spots and instabilities. Optimizing the combustion process has been shown to decrease total fuel usage by at least 5%, with a corresponding decrease in CO, CO₂, and NO_x emissions. The Gas Technology Institute and project partners have field tested the system.

Contact: David Rue from Gas Technology Institute at david.rue@gastechnology.org

Intelligent Extruder Software for Polymer Compounding



The Intelligent Extruder software is a powerful new system for closed-loop control of compounding extruders used to manufacture thermoplastics. The system improves the mixing, melting, and devolatilization of additives by monitoring viscosity and manipulating composition of the feed. This helps to maintain tighter control of material properties, lower production costs, and reduce energy use and waste generation. GE developed this software with industrial collaborators and is now exploring commercialization opportunities.

Contact: Paul Houpt from GE at haupt@research.ge.com

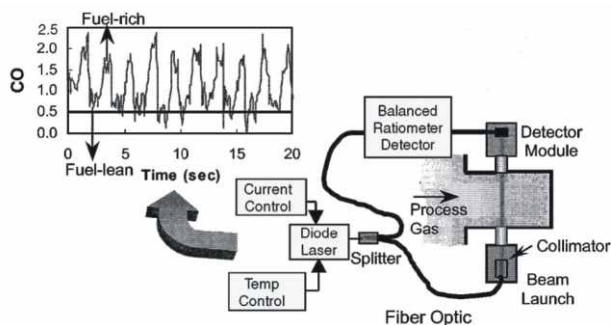
Flame Image Analysis for Natural Gas-Fired Furnaces



The University of Missouri-Columbia developed new sensors that provide real-time detection of flame properties and 3-D temperature profiling for gas-fired furnaces. This system's novel monitoring capabilities increase efficiency, improve product quality, and lower NO_x and carbon monoxide emissions. The sensors can be integrated with the furnace control system, or they can be utilized as a diagnostic tool for manual control adjustments. Potential applications include melting or reheating furnaces that are used in the glass, aluminum, steel, and forging industries. The system has shown promising results in commercial testing.

Contact: Shahla Keyvan from the University of Missouri-Columbia at Keyvan@missouri.edu

Tunable Diode Laser Sensor for Combustion Control

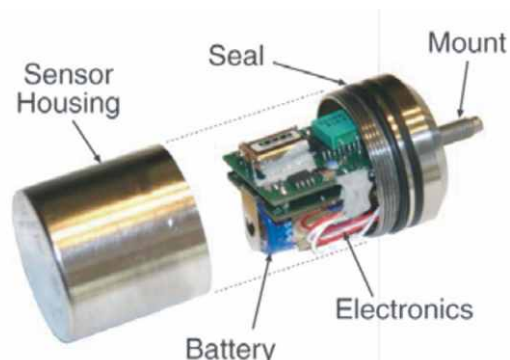


This sensor system uses tunable diode lasers to measure gas temperature and the concentration of carbon monoxide, oxygen, and water vapor in industrial furnaces. Monitoring these chemical species is key to improving energy efficiency, reducing pollutants, and improving process quality. In contrast to conventional analysis techniques, which typically rely on extractive sampling, this in-situ system allows for real-time control. The diode laser system is compact and rugged, requiring little maintenance. American Air Liquide has completed plant tests in a steel reheat furnace and a secondary aluminum furnace, as well as long-term tests in an electric arc furnace.

Contact: William Von Drasek from American Air Liquide at Bill.VonDrasek@AirLiquide.com

Pavol Pranda from American Air Liquide at Pavol.Pranda@AirLiquide.com

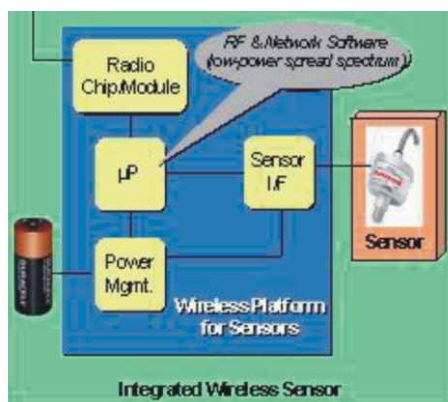
Distributed Wireless Multisensors for Reducing Motor Energy Use



These multisensors are installed on electric motors to directly measure parameters such as current, vibration, and temperature. The inexpensive sensors will make continuous monitoring of even small motors economical, and thereby allow industries to maintain the performance of all their motors. GE Global Research is leading development of the sensors and the wireless technology to connect them, and is now field testing a prototype sensor network.

Contact: Daniel Sexton from GE at sextonda@crd.ge.com

Wireless Sensors for Process Stream Sampling and Analysis



This three-part project is developing the technology for preconcentrating and determining the composition of gaseous process streams, a standardized process stream sampling and microanalytical system, and the architecture for a robust wireless sensor communication network. Together, the wireless measurement system will allow continuous monitoring and diagnostics of industrial processes, improving product quality and reducing process upsets. Honeywell International is testing the system with project partners, and will use it to pave the way for other wireless control systems enabling further quality control and process optimization.

Contact: Steve Huseth from Honeywell International at Steve.huseth@honeywell.com

On-Line Sensor System for Molecular Analysis



This sensor system uses transient infrared spectroscopy to monitor physical properties of polymer extrusions and coatings. The output from this system could be linked to process control systems to provide real-time feedback on process variables. Ames Laboratory developed this technology, and has successfully tested the system in three pilot-scale industrial applications. Material properties measured include material composition, thickness, and tensile strength.

Contact: John McClelland from Ames Laboratory at mcclelland@ameslab.gov

Cavity-Enhanced Gas Analyzer for Process Control



Los Gatos Research and its commercialization partners have developed an industrial process control analyzer for measuring trace acetylene concentrations in ethylene gas flows. Acetylene contamination can lead to costly upsets in the production of ethylene, the world's largest volume and revenue-generating organic chemical. The new analyzer utilizes Los Gatos Research's patented Off-Axis Integrated Cavity Output Spectroscopy (Off-Axis ICOS) technology and is fifty times faster and less expensive than conventional gas chromatography. The unit has been successfully field-tested at Dow Chemical Company and initial product sales are expected to commence in early 2006.

Contact: Manish Gupta from Los Gatos Research at m.gupta@lgrinc.com

Broadly Tunable Mid-Infrared Laser-Based Spectrometer



This versatile broadly tunable spectrometer can measure multiple gaseous hydrocarbons for industrial process control. Existing spectrometers lack the tuning range to detect multiple end products of hydrocarbon cracking processes. And unlike conventional gas chromatography, this laser-based spectrometer is rugged, compact, and makes measurements in seconds rather than minutes, allowing real-time control. Physical Sciences has completed initial testing and is building a compact prototype for field testing.

Contact: Douglas Bamford from Physical Sciences, Inc. Douglas Bamford at bamford@psicorp.com

Wireless Sensor Network for Motor Energy Management



Industrial electric motors consume an estimated 679 billion kWh, or 23% of all electricity sold in the United States. The energy used by large motors has already been reduced with advanced monitoring and diagnostic systems. Deploying these monitoring systems on smaller motors could further reduce energy use by up to 18%, but it is not economically feasible to install them with conventional field wiring. Eaton is leading a project to remove this cost barrier by developing wireless sensors that measure voltage and current and integrate with Eaton's advanced energy management software. They are testing a variety of prototypes in laboratory and industrial environments.

Contact: José A. Gutierrez from Eaton Corporation's Innovation Center at JoseGutierrez@eaton.com

Gas Metal Arc Welding Optimization

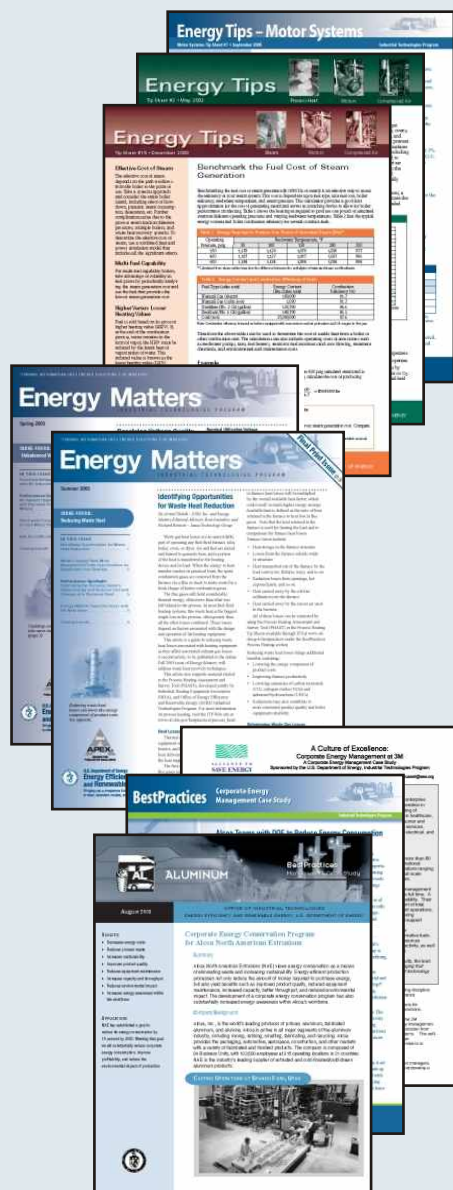


Researchers at Oak Ridge National Lab, Pennsylvania State University, and Lincoln Electric Company are developing an integrated model for gas metal arc welding that will allow optimization of welding processes. Previous models have focused on heat transfer, fluid flow, or other physical processes, without fully addressing the interrelationship between them. The new hybrid model combines fundamental approaches based on physical principles with neural networks based on experimental data. It thereby gives a complete model of the welding process, including weld pool shape and microstructure evolution.

Contact: Tarasankar DebRoy from Pennsylvania State University at rtd1@psu.edu

RESOURCES FOR TODAY

U.S. companies are using DOE resources to identify opportunities for quick-payback process improvements that save energy.



DOE resources are available to help industry boost energy efficiency today. Most items are available on-line or may be obtained at no cost.

- Case studies
- Training
- Tip sheets
- Plant-wide assessments
- Publications
- Software tools

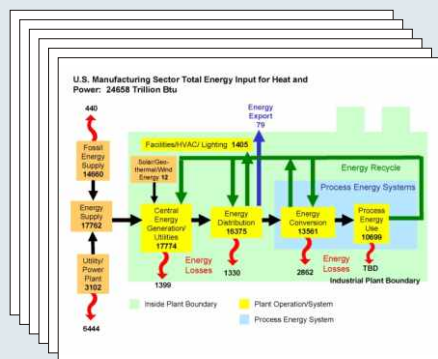
To learn more, contact the EERE Information Center (1-877-337-3463) or visit the Technology Delivery web site at www.eere.doe.gov/industry/bestpractices

Don't miss the industry-specific resources available on our web site at www.eere.doe.gov/industry

Join the DOE campaign to help U.S. manufacturing plants Save Energy Now:

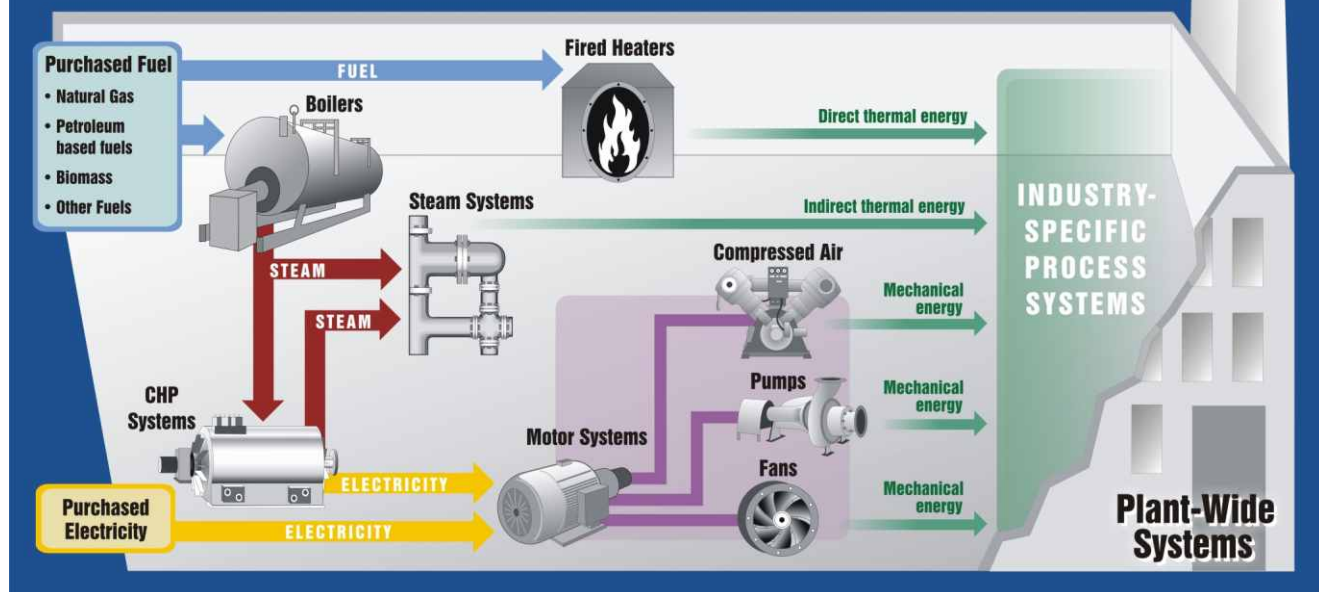
- ✓ **Plant Assessments** performed by ITP's Industrial Assessment Centers (IAC) and energy efficiency experts to identify energy savings opportunity.
- ✓ **Access to ITP's extensive portfolio**, including tip sheets, case studies, handbooks, and more.
- ✓ **Recognition on the ITP Web site.**
- ✓ **Phone consultations and technical assistance** provided by experts at the EERE Information Center.
- ✓ **ITP's software analysis tools**, including instructional training, web casts, and workshops.

Visit the web site at www.eere.energy.gov/industry/saveenergynow/



Energy Use Footprints

To identify the top energy-saving opportunities, DOE offers free software tools and training.



Software Tools are available to identify the best opportunities for saving energy and costs:

- AIRMaster+
- Chilled Water System Analysis Tool (CWSAT)
- Combined Heat and Power Application Tool (CHP)
- Fan System Assessment Tool (FSAT)
- MotorMaster+ 4.0
- MotorMaster+ International
- NOx and Energy Assessment Tool (NxEAT)
- Plant Energy Profiler for the Chemical Industry (ChemPEP Tool)
- Process Heating Assessment and Survey Tool (PHAST)
- Pumping System Assessment Tool 2004 (PSAT)
- Steam System Tool Suite

Training sessions provided by DOE help operators run plants and mills more efficiently. Sessions focus on effective use of system-wide and component-specific software tools. Training is available throughout the year and around the country.

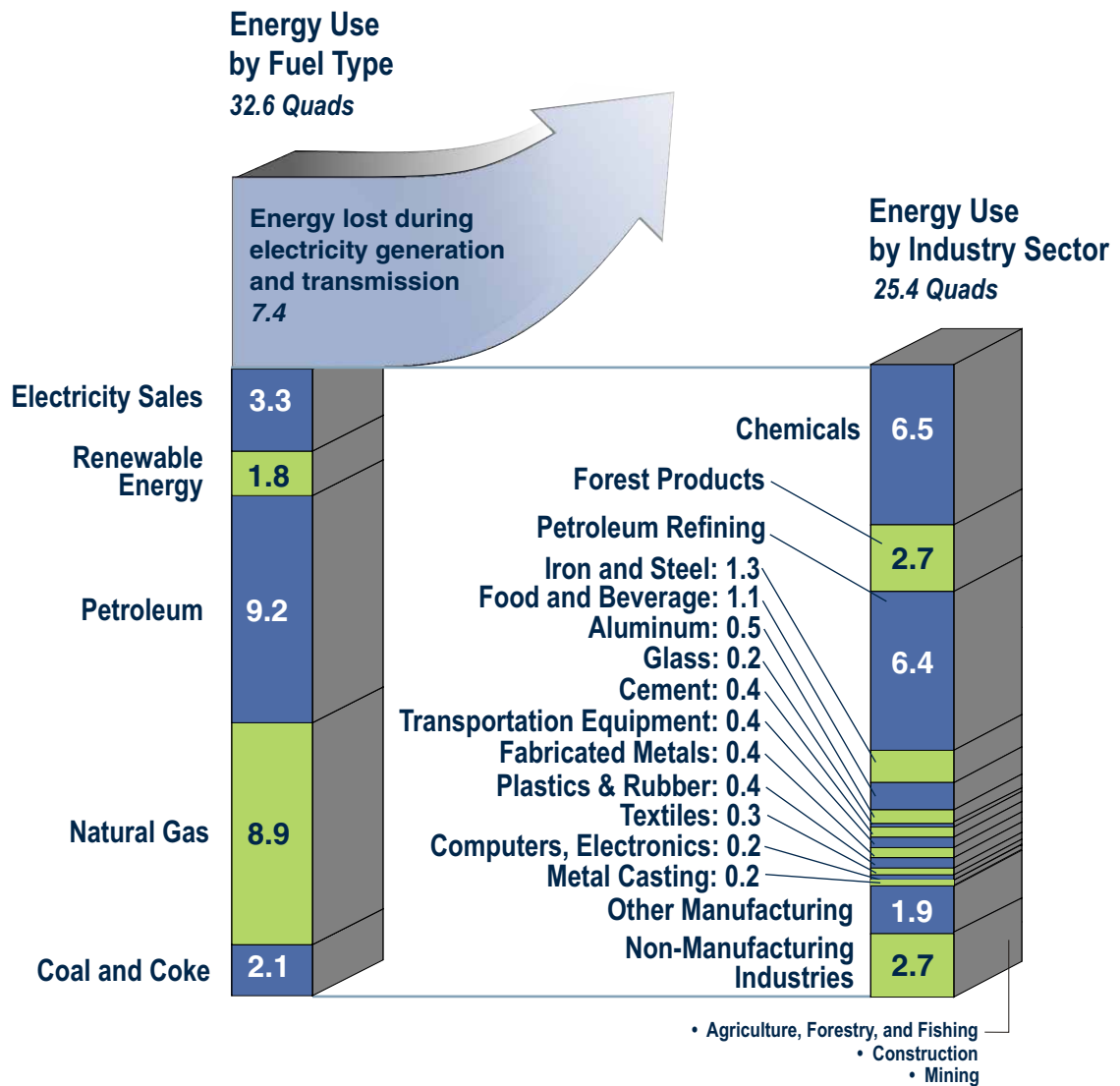
Training Session Topics:

- Compressed Air Systems
- Steam Systems
- Process Heating Systems
- Pump Systems
- Fan Systems

DOE and industry partners periodically host one-day workshops to help plants and mills identify and implement energy and greenhouse gas savings opportunities.

U.S. Industrial Sector Energy Use—A Snapshot

Industrial Energy Use by Fuel Type and Industry Sector (2002)



Technologies co-funded by DOE reduce the energy intensity of industrial processes.

The EERE Industrial Technologies Program responds to the unique challenges facing industry.

Industrial Research Partnerships

- ▶ Support collaborative R&D in manufacturing processes and technologies
- ▶ Demonstrate promising technologies
- ▶ Promote the adoption of best practices and emerging technologies

R&D Focus: Transformational technologies that are too risky or costly to attract adequate private funding.

Targets

- ▶ Significant energy savings
- ▶ Industry-defined priorities
- ▶ DOE and National Energy Policy goals

Industry partners help DOE to . . .

- ▶ Identify R&D priorities
- ▶ Gain industry feedback on the R&D portfolio
- ▶ Cost-share innovative technology development
- ▶ Communicate research results to industry

DOE builds and maintains robust R&D portfolios for energy-intensive industries by conducting . . .

- ▶ Technology and market analyses
- ▶ Expert peer reviews
- ▶ Stage-gate management

Technical innovation is critical to long-term competitiveness.



**A Strong Energy Portfolio
for a Strong America**

Energy efficiency and clean, renewable energy will mean a stronger economy, a cleaner environment, and greater energy independence for America. Working with a wide array of state, community, industry, and university partners, the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy invests in a diverse portfolio of energy technologies.

For more information contact:
EERE Information Center
1-877-EERE-INF (1-877-337-3463)
www.eere.energy.gov

Visit the DOE website at
www.eere.energy.gov/industry